

Adapting a Design and Technology project to reflect the changing requirements of working within the Science and Technology AoLE: A case study

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ABSTRACT

Industry leaders often highlight the need for employees who can think beyond the boundaries traditionally imposed by subjects. Numerous countries are introducing some form of interdisciplinary learning and a holistic approach to knowledge acquisition to potentially offer young people a head start in today's dynamic and ultra-competitive jobs market.

This case study of two Year 9 classes (n=28) at one secondary school in South Wales, investigated how integrating interdisciplinary links into Design and Technology education enhances learners' holistic understanding and improves contextual solutions. Situated within the new requirements of the Science and Technology Area of Learning and Experience (AoLE) in the Curriculum for Wales (CfW) and its focus on interdisciplinary learning, adaptation, delivery, evaluation, and assessment methods were critically explored.

Data was collected through questionnaires, interviews, and observations of learner output. Results indicate that explicit interdisciplinary links improve learner engagement, understanding, and knowledge application across subjects. This has implications for Design and Technology delivery and beyond as educators in Wales look to create truly cross-curricular opportunities for learners.

Keywords: design and technology, projects, science and technology, area of learning and experience, AoLE, curriculum for wales

Introduction

As part of the major ongoing education system-level reforms currently taking place in Wales (Welsh Government, 2023), Design and Technology (DT) forms part of the Science and Technology Area of Learning and Experience (AoLE) in the new Curriculum for Wales' (CfW) (Welsh Government, 2024; Crick, 2021). The DT space is naturally interdisciplinary, an amalgamation of Science, Technology, Engineering, and Mathematics (STEM) subjects working towards the singular objective of a better product (Bell et al., 2017). Using a project-based approach allows for a level of interdisciplinary responsiveness in both content and delivery that gives the subject relevance in a rapidly changing industrial landscape, perhaps exemplified through the widespread social, cultural and economic impact of artificial intelligence (Dwivedi et al., 2021). Authenticity in real-time can be a powerful way to help learners engage in seemingly disparate topics. Research has shown students tend to show increased engagement and interest in cross curricular projects and classes (Fletcher-Wood, 2016; Ng and Fergusson, 2020). Mansilla and Duraising (2010) found that teachers of interdisciplinary classes expected students to learn to think for themselves and develop critical awareness to solve problems. This study examined Year 9 learner experiences, and engagement, of a solution-focused cross-curricular project in DT.

Literature Review

Research suggests that current education techniques are not preparing students to be creative, collaborative problem-solvers (Castro and Totah, 2017; You, 2017). However, evidence suggests that interdisciplinary learning provides opportunities for students to experience cross-curricular connections which in turn lead to a more meaningful learning experience (You, 2017). Shared experiences across different courses can enhance students' interdisciplinary awareness and practical skills (Reviere et al., 2024). As Savage (2012, p.87) asserts, 'there are examples of

teachers working creatively at a cross-curricular pedagogy in strongly framed, subject orientated school contexts', demonstrating how educators are beginning to break out of the historically embedded silos. This is particularly relevant in the context of explicit curriculum leadership, alongside school and system improvement in Wales (Harris et al., 2020).

Hubert (2021, p. 67) stated, 'learning in the 21st century is about making connections between ideas, fields, and concepts. Therefore, schools must teach students how to make these connections'. This resonates with the wider concept of 'cynffin' (belonging) within the new Curriculum for Wales (Chapman et al., 2023). As schools shift from centrally curated learning toward local projects, Savage (2012) questions whether teachers will maintain connections within their teaching approaches, which has been questioned across all six AoLEs of the Curriculum for Wales (Griffiths et al., 2025). The strength of these educational connections may increasingly depend on external factors outside student control, contributing to their cultural capital.

Authenticity is essential for delivering content in a way students can connect with. In practical scenarios, disciplines rarely exist in isolation. Creative Australia (2021) notes, 'we must improve how we communicate the importance of cross-disciplinary learning to both educators and students pursuing creative fields'. Baskaran and Abdullah (2020) further emphasise that the best way to teach science is by using an authentic and relatable approach.

Pedagogical Progression

A new qualification structure proposed as part of the implementation of CfW aims to better recognise learners' efforts. However, Power, Newton and Taylor (2020) suggest adaptability may lead to varying assessment approaches, creating challenges in comparing progression across contexts. They further emphasise that the transition from standardised testing toward growth-oriented learning perspectives makes it difficult to establish consistent metrics for evaluating success.

Bell et al. (2017) explored the relationship of DT within STEM, finding it occupies a position between academic and vocational identities, integrating knowledge from across science, technology, engineering, and mathematics to provide a well-rounded educational experience, and lending itself to authentic, real-world scenarios. As

interdisciplinary learning becomes prevalent, there has been a shift toward integrating multiple disciplines (Lina, Wei and Chen, 2017). Balancing life skills and academic priorities is crucial for developing healthy learners and preparing them for real-world experiences; the challenge is thus avoiding superficial subject delivery while ensuring learners can disseminate discipline-specific content.

To be effective in seeking out new ideas and methods tacit knowledge can often support the routine application of skills and/or process. This same tacit knowledge encompasses experience, values, and intuition (Bertola and Teixeira, 2002) crucial in embedding authenticity. In their 2012 research 'Transforming Constructivist Learning into Action: Design Thinking in Education', Scheer, Noweski, and Meinel (2012) demonstrate how Design Thinking, a core component of DT, serves as a team-based learning process fostering constructivist learning. This builds on Siraj-Blatchford's 1993 work 'Constructing Design and Technology: An Early Years Perspective' argues that a pedagogic model grounded in constructivist and Vygotskyian theory can be consistently applied throughout DT education.

Methods

In critically exploring how a DT project could successfully integrate both scientific and technological principles, the following research questions were posed:

- How do learners experience the project?
- What aspects of the project support better integration of the Science and Technology AoLE?

Currently Science and DT are assessed separately; to fully realise this interdisciplinary structure elements of the process must be amalgamated to create a single outcome encompassing elements of both subjects. Crucially their application must be in an authentic situation. DT projects are deeply rooted in constructivist learning models, promoting active, experiential learning where students construct knowledge through practical, hands-on activities. This student-centred, rather than instructor-led, learning occurs when new understandings are related to existing concepts and cognitive structures, highlighting the constructivist approach inherent in DT projects.

Table 1: Composition of Year 9 classes including common school measures.

Class	Total in group	Male	Female	SEN	Average predicted GCSE level	Average current GCSE level
A	12	5	7	0	B	B
B	16	13	3	2	C	D

Sampling procedure and description

The sample included pupils (n=28) from two Year 9 classes (Class A / Class B) taught in parallel by me as their DT teacher. Data were gathered to elicit pupil perspectives at various stages of the project via two focus groups drawn from both classes. Class 2 was predominantly male, consisting of pupils with lower prior attainment (see Table 1). Class 1, although more evenly balanced, has higher predicted GCSE grade attainment, however, experience of teaching these groups suggests they may lack originality.

Ethics

The biggest ethical issue faced was the intrinsic power dynamic between me, as a DT teacher, and the pupils taking part in the research. It is important that the simultaneous roles of teacher and researcher do not cause a conflict of interest, where learners potentially wishing to ingratiate themselves raises risk of response bias to the data collected. To separate the role of teacher and researcher it was made clear to learners at regular points during the project that their responses would not impact on the mark awarded for their work. I explained the project to both classes and methods of data collection and explained their right to withdraw at any point during data collection. N=6 pupils across the two classes volunteered to participate in the focus groups. Ethical approval was granted from the University's ethics committee prior to any data collection.

To fully investigate the effect of an interdisciplinary project I developed a project with Year 9 over a period of eight weeks that could be delivered via local

science or technology curricula. The project required learners to design and prototype an acoustic amplifier. Usually, delivery focuses on either the aesthetics and finish as a DT project or increasing the amplitude (i.e. a measurable output) as a scientific investigation; but rarely both. Both groups chose to follow a delivery that included elements of both DT and Science. The additional objectives focus on the amplification and how the scope of ideation can be widened to balance both aspects, in short learners are required to design a product where both are equally valued, ideally developed as one.

Amplification facilitates the seamless integration of both design and science as equal drivers of success. Following Freire's (1982) philosophy, that action research is an opportunity to involve those who are directly affected by the results, I developed and introduced a single 'change' rather than trialling numerous iterations and interventions aiming to further reduce the power dynamics between researchers and participants (Freire, 1982).

Multiple methods of data collection were used to allow triangulation. These included three online questionnaires distributed to all learners at the beginning, middle and end of the project to identify learners' perceptions and the capacity to think in an interdisciplinary manner. Questionnaires were followed by 10-minute focus groups (one per class) with three pupils to further explore learner responses to the questionnaire. Finally regular observations of learner workbooks were conducted to ascertain levels of interdisciplinary learning from the project.

Data Generation and analysis

Data were collected and analysed using the six steps of reflexive thematic analysis as detailed by Braun and Clarke (2006) namely, familiarising myself with the data, generating succinct labels, or coding, before searching and then reviewing them before defining and then naming them. To minimise bias while interrogating data, comments made were triangulated across multiple data sets to confirm trends. Themes emerging from the data included cross curricular engagement and understanding, and the value of learner feedback.

Results and Discussion

It became clear from the data that learners not only appreciated the cross-curricular elements but felt that the quality of their work improved as they better understood what they were doing. As one learner commented in an interview, '[the project is] better because we looked at them first because we actually know what we're doing and how to make it louder'. Learners valued the increased agency afforded and the authentic outcome reached.

It became apparent that the intervention was having a positive effect on learner engagement and subsequent understanding visible both in the regular work scrutiny taking place and the resultant conversations with learners. This demonstrates a potential effect that changes in delivery had in ensuring the direct link between teaching and learning.

Cross curricular understanding

One issue encountered during the case study was the difference in abilities requiring variations of scaffolding to allow individuals to access the work. This has been, and continues to be, one of the challenges of a successful lesson; being able to seamlessly create access and support progression for the whole class, regardless of ability.

The development process clearly illustrated decisions and reasoning; learners applied principles from both design technology and science lessons effectively. On observing workbooks, one pupil had annotated, '...guitar shape appeals to target market and uses exponential trumpet shapes to increase volume – curve helps with this', demonstrating the simultaneous application of scientific and aesthetic requirements.

Most students planned to gift or use their amplifier, with the majority (82 per cent, 23/28) eventually taking them home, showing higher engagement than typical projects. The increased ownership demonstrates how a well-designed project with individual agency increases motivation in line with Kotys-Schwartz and Cooper's research, which found that the introduction of a(n authentic) client can enhance authenticity, contribute to students' feelings of accountability, and can provide a new experience of designing to meet the needs of someone else versus

simply earning a course grade, which aligns with established principles in educational literature, particularly concerning authentic learning and assessment. Most learners (71 per cent, 20/28) showed clear linear progression using given information. Scientific connections helped learners connect experience, theoretical knowledge with practical applications. Greater emphasis on linking topics clearly enables learners to apply previously separate knowledge, a view shared by Lin et al. (2020, p.1–18) in their research on design-based learning, who state 'knowledge integration can reduce the fragmentation of learners' knowledge and form long-term comprehension by integrating knowledge to enhance learning performance'.

Cross curricular engagement

Engagement has been defined as participation in educationally effective practices both inside and outside the classroom (Kuh et al., 2007). While some researchers believe that participation on its own is sufficient, Harper and Quaye (2009) see emotions as a cornerstone of engagement, key to creating a productive learning environment through which learners can progress. The authenticity created by linking previously disparate knowledge is something that clearly engages learners.

Although not officially grouped by ability simply due to their other subject choices it transpired that one group was significantly more able (using both the schools standardised metrics and assessment for learning) than the other. Learners across both groups showed an increased ability to connect scientific principles with design decisions, leading to more functional and aesthetically pleasing outcomes, something that was apparent through work scrutiny, specifically the illustrations focusing on the scientific principles of how soundwaves are amplified and how this could affect the shape of their final product. The research also highlights the importance of authentic, real-world applications in motivating learners. Challenges in assessment and the need for collaborative curriculum development across disciplines were identified. This increase in understanding and ownership was also apparent, learner agency within the brief is crucial for engagement, as Reeve and Tseng (2011, p. 257–67) note, students 'intentionally try to personalise what is to be learned and the conditions under which it is learned.' The open brief and personalisation improved engagement across all work aspects. The authentic application allowed learners to create something with real-world use.

Learner feedback

Through the learner's output and engagement, in addition to pupil voice feedback, it became apparent that learners considered their work improved with increased understanding. A majority of learners (89 per cent, 25/28) were able to make a direct connection between what they had been taught in science, revisited in DT and to apply it in their design development. Most were able to use the correct terminology when explaining their decision-making process. Learners valued explanation of the interdisciplinary elements of the project and felt that their speakers were more effective than they would have been without the scientific grounding. Design decisions seemed to be based on an understanding of the physical acoustics (Science) rather than just trying to create the aesthetic (DT) they wanted. This mirrors van Riesen et al. (2018) who investigated how scaffolding students' experiment design through inquiry-based teaching improved their design outcomes. The study found that providing structured support led to more scientifically rigorous and effective designs; grounding learners' designs in scientific principles enhances their effectiveness.

Possible implications

Rather than relying on achieving levels, CfW uses progression steps to describe learning progress to encourage teachers to focus on depth of understanding over speed of coverage. Learners can revisit and consolidate concepts as needed, aiming for deep, secure learning rather than superficial achievement of content. These statements provide a holistic view of requirements and what each topic or project can offer. Hwb, the pan-Wales education portal, states in its introduction that the new AoLE will 'engage (learners) with technological and scientific change and be inspired to take design risks, innovate and solve problems'. DT is thus an amalgamation of various disciplines coming together to achieve a goal.

Simply moving to an interdisciplinary project-based curriculum has its own distinct problems, however. As an example, when looking at Scotland's Curriculum for Excellence, the Royal Society of Education (2017) noted that it 'should not involve random subject collaborations or rebranding and "bolting-on" of existing materials', warning that, 'disciplinary knowledge should be evident to learners...

there may be areas of science that are better taught as more traditional disciplinary science rather than within interdisciplinary projects and contexts. Experience and good judgement are required'. Ensuring understanding and delivering related skills as one in an engaging and authentic context although preferable in most situations is far from a blanket solution. An individual's functional outcome is important for continued engagement and self-confidence within the subject. Learners' sense of control, beliefs about themselves and their learning, and confidence affect learner agency (Mercer, 2011; Mercer, 2012; Tao and Gao, 2021).

Conclusion

The traditional 'process' of designing curricula can either limit a learners' creativity by consigning them to a predetermined route or ensure they meet certain objectives on their journey to an outcome. The challenge for educators is enabling learners to access the necessary knowledge and skills, making sure they are understood in context, while practising them authentically.

Approaching problems with an interdisciplinary mindset involves using all available resources rather than limiting output to what is traditionally seen as 'within remit'. Educators thus need to focus on the authentic application of skills in lessons and how these can be applied beyond the classroom. This raises significant opportunities for DT as an interdisciplinary theme within the Science and Technology AoLE in the new Curriculum for Wales.

Acknowledgements

My research was undertaken whilst completing the National MA in Education at Cardiff Metropolitan University. Without Dr James Snook (dissertation supervisor), Dr Rhiannon Packer (Programme Director) and Jason Davies (Programme Leader for PGCE Secondary DT and ICT) my research would not have the rigour and direction to give such an insight. I am indebted to all three for their unwavering support.

I would like to recognise the support from staff and learners for the engagement and feedback that has been instrumental in my research.

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