



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

MODULE CODE: ECAD5017

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AI Acknowledgement

I acknowledge the use of ChatGPT (<https://chatgpt.com/>) on 9th May 2025 using the prompt(s):

1. Find the most relevant and recent sources to evidence the effective teaching of STEM activities among 7-11 year olds within the Curriculum for Wales.

2. Find me key educational theorists who support an inquiry-based approach to STEM education among 7-11 year olds.
3. Proofread this paragraph, ensuring accurate educational tone and effective sentence structure.

I confirm that I have not presented any AI generated text as my own work.

Targets From Previous Assignment	How I Have Addressed These Targets Within This Assignment
Avoid short paragraphs (two sentences long).	Throughout this assignment, I have met the target of avoiding short paragraphs by ensuring that each paragraph develops a clear, well-supported point with sufficient depth, typically comprising at least four to six sentences.
Use your professional standards and relevant literature to guide next steps. What impact will your findings have on your own future teaching practice?	In this assignment, I have used the Professional Standards, alongside relevant literature, to reflect critically on effective practice in STEM teaching and identify practical next steps that will inform my future teaching practice.

ECAD5017 – Deepening Practice: Science and Technology

Assessment Component 1: Document your design and rationale of a STEM Education Activity for Children Aged 7-11 Years.

Journal Paper: Emphasising Theory and Literature Engagement

Introduction:

STEM education; encompassing science, technology, engineering, and mathematics, plays a vital role in developing the analytical, problem-solving, and creative thinking skills necessary for future success in a rapidly evolving world (Murphy et al., 2019). In a Welsh context, the Curriculum for Wales (2022) places strong emphasis on interdisciplinary and experiential learning within the Area of Learning and Experience (AoLE) of Science and Technology, encouraging educators to design STEM activities that promote curiosity and real-world application from an early age (Welsh Government, 2022). For Key Stage 2 learners (aged 7-11), this is a critical period in which foundational knowledge in STEM can be deepened through engaging, inquiry-based activities that reflect the four purposes of the curriculum, particularly enabling learners to become enterprising and creative contributors (Welsh Government, 2022).

Recent evaluations by Estyn (2023) highlight that effective STEM enrichment programmes not only enhance academic attainment but also significantly boost pupil engagement, especially when activities are learner-led and rooted in real-world contexts. One impactful framework supporting this approach is the CREST Award scheme (CREST, 2024), which promotes inquiry-based, hands-on STEM projects aligned with pupils' interests and abilities, linking directly to appropriate progression steps and their corresponding descriptions of learning (Welsh Government, 2022). This paper documents a STEM education activity design, integrating a CREST Discovery Award, offering year 6 learners a structured yet flexible way to develop collaboration, investigation, enquiry and communication skills within a recognised national framework. The proposed activity is underpinned by relevant

educational theory and literature and designed to meet the criteria of the CREST Award, thereby fostering essential STEM competencies and supporting a confident transition into secondary education.

The documented activity focuses on the CREST theme of 'Living Things' and Making Toothpaste (CREST, 2024). It is a 5-hour duration activity involving STEM sessions tailored for Year 6 learners, focusing on how living organisms such as bacteria impact dental health and how toothpaste ingredients protect against decay. Closely aligned with the Science and Technology AoLE, within the Curriculum for Wales (Welsh Government, 2022), the activity addresses Progression Step 3, supporting learners to "use their knowledge of the properties of materials to suggest uses" and to "draw upon knowledge of systems in the human body to explain health-related processes." Through inquiry-based experiments and hands-on group tasks, including testing acid effects on eggshells and formulating homemade toothpaste, learners will develop scientific reasoning, collaboration, and product evaluation skills in authentic, real-world contexts.

Theoretical Foundations (400 words):

The design of effective STEM education activities for learners aged 7-11 must be grounded in established educational theory. Central to this is constructivist learning theory, which describes that learners construct knowledge through active engagement with their environment (Piaget, 1952). Constructivism supports the use of hands-on STEM tasks, such as building, testing, and modifying models, where learners can explore scientific concepts in a concrete and meaningful way (Fosnot, 2013). Vygotsky's (1978) socio-constructivist approach further develops this by highlighting the importance of social interaction and scaffolding. Group work is especially valuable at this developmental stage, as children benefit from dialogue, idea exchange, and peer modelling within their Zone of Proximal Development (ZPD), enabling higher-level thinking through supported learning (Mercer, 2000).

Inquiry-based learning also aligns with constructivist pedagogy, emphasising the importance of exploration, questioning, and reflection. As Pedaste et al. (2015) outline, inquiry involves structured phases, orientation, conceptualisation, investigation, and conclusion, that mirror scientific processes. Embedding these stages into STEM activities encourages critical thinking and resilience, particularly when students are encouraged to formulate hypotheses and test solutions collaboratively. Research shows that inquiry-based methods in primary STEM education improve both conceptual understanding and student motivation in the AoLE of Science and Technology (Harlen, 2010; de Jong, 2020).

From a developmental psychology perspective, children aged 7–11 are within Piaget's concrete operational stage, where they develop logical thinking about tangible concepts but still struggle with abstract reasoning (Piaget, 1952). Therefore, STEM activities should be practical and sensory-rich to align with this developmental stage (Case, 1992). Tasks that involve manipulating materials, recording results, and discussing findings in groups are developmentally appropriate and cognitively stimulating. Furthermore, well-structured group work also fosters social development, promoting communication, empathy, and cooperative learning skills (Gillies, 2016).

Literature Review:

The proposed activity has been designed to align with Progression Step 3 of the Curriculum for Wales: Science and Technology AoLE (Welsh Government, 2022), encouraging learners to explore materials, living systems, and health through investigative, real-world contexts. The activity aims to support the development of scientific understanding, inquiry skills, and collaboration by integrating current pedagogical theories with practical, engaging tasks. Each session, ranging from testing acid effects on eggshells to branding homemade toothpaste, is informed by a critical reading of research into STEM education, constructivist learning, and cognitive development in children aged 7–11.

Constructivist theory provides a strong foundation for the activity, particularly Piaget's (1952) view that children at the concrete operational stage learn best through hands-on manipulation of materials. Experiments such as testing toothpaste effectiveness or mixing ingredients are designed to support experiential learning. However, critics argue that constructivist methods, while engaging, may lack the structure some learners need to consolidate complex scientific concepts (Kirschner, Sweller and Clark, 2006). To mitigate this, the activity incorporates scaffolding through guided instruction and peer support, aligning with Vygotsky's (1978) Zone of Proximal Development, where more capable peers and adults help bridge gaps in understanding.

The activity also adopts an inquiry-based learning approach, following the structured cycle outlined by Pedaste et al. (2015), including hypothesis formation, investigation, and reflection. Research by Harlen (2010) supports this, showing that children develop stronger conceptual understanding when they are given autonomy to explore questions. Yet, other scholars caution that inquiry-based learning can lead to misconceptions if not well-structured (Mayer, 2004). This is addressed in the session design by explicitly modelling each phase of the inquiry process and embedding time for whole-class reflection to consolidate findings, particularly during the final Reflection and Presentation session.

In terms of cognitive development, the activity is also underpinned by the theory of schemas, which describe how children form mental frameworks to process new information (Athey, 2007). For instance, children use and revise existing schemas about hygiene, health, and materials when they observe how different toothpaste formulas protect against acid erosion. However, as Wood (2020) points out, schemas develop at different rates and are influenced by prior experience, suggesting the activity must accommodate a range of entry points and levels of prior knowledge. Differentiation and mixed-ability grouping are therefore embedded into the activity to allow all learners to access the content meaningfully.

The role of collaborative learning is also central. Structured group work during experiments and design tasks is informed by the Education Endowment Foundation (EEF, 2021), which found that cooperative learning can add up to +5 months' progress in learning in science. However, the EEF also notes that the effectiveness of group work depends on the quality of task design and role clarity. To address this, the session plan assigns rotating roles (e.g. materials manager, recorder, spokesperson) and includes prompts to develop pupils' collaborative skills explicitly (Gillies, 2016).

Finally, the use of the CREST Discovery Award adds a formalised, real-world framework for inquiry and innovation. The award structure is consistent with the Curriculum for Wales' emphasis on applied learning and encourages learners to communicate scientific ideas effectively (CREST, 2024). While some educators may view external awards as performative or overly structured, in this case the CREST framework enhances motivation and provides meaningful recognition for pupils' efforts, supporting both engagement and progression.

Link to Teaching Standards and Professional Development:

Designing this STEM activity has significantly contributed to my professional preparedness for future teaching scenarios. The process of aligning lesson content with the Curriculum for Wales, integrating progression step 3 outcomes, and embedding pedagogical principles such as inquiry-based learning and constructivism (Bruner, 1966; Dewey, 1938) has deepened my understanding of curriculum design and learner development. Anticipating potential challenges, such as differentiation and timing, while also planning for real-world relevance has developed my confidence in creating meaningful, inclusive learning experiences. This experience has also highlighted the value of reflective planning, collaborative feedback, and evidence-informed decision-making, all of which are essential components of effective teaching practice (Donaldson, 2015). Going forward, I feel better equipped to design adaptable, engaging lessons that meet the diverse needs of learners while maintaining a strong theoretical and curriculum-based foundation.

Conclusion:

The proposed activity demonstrates how purposeful planning, informed by educational research and reflective practice, can enhance learner engagement and progression across the Curriculum for Wales. Key insights have included the value of structured collaboration (EEF, 2021), the importance of developmental appropriateness, and the need for balance between autonomy and scaffolding. Professional learning throughout this process has deepened my understanding of curriculum design, effective pedagogy, and learner-centred approaches to STEM education within the AoLE of Science and Technology.

Regarding future teaching practice, I will continue to draw on theory, research, and reflective inquiry to design meaningful STEM learning experiences that empower young learners to think and work like scientists, both within and beyond the classroom.

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