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Towards a Framework for STEAM Education in Youthreach in Ireland: Building on stakeholder perspectives

Eilish McLoughlin, Ruth Chadwick
CASTeL & School of Physical Sciences, Dublin City University, Dublin, Ireland

ABSTRACT

STEAM education is a pedagogical approach that merges science, technology, engineering, arts and mathematics and aims to develop learner knowledge, skills/life skills and attitudes, while promoting engagement. It can be particularly relevant in alternative education provision settings, such as the Youthreach programme for early school leavers, in Ireland. This research is based on the implementation of a two-year project "Full STEAM ahead: A partnership approach to STEAM in Youthreach". This paper presents the approach adopted to design a Framework for STEAM Education in Youthreach, developed in light of current literature and through co-creation between researchers and stakeholders, over the first year of the project. Stakeholder viewpoints were gathered through interviews, then analysed through qualitative content analysis. This involved comparing interview transcripts to a pre-determined coding frame based on the Framework for STEAM Education in Youthreach. The Framework identifies STEAM; STEAM learning outcomes; STEAM session supports; and STEAM assessment. The proposed Framework is informed by the innovative and emerging field of literature in STEAM education and the important role that STEAM education can play within Youthreach alternative education provision in Ireland.

KEYWORDS

STEAM, alternative education, Youthreach, framework, competences

CONTACT Eilish McLoughlin eilish.mcloughlin@dcu.ie

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Introduction

STEAM education

STEAM education is a pedagogical approach that merges science, technology, engineering, arts and mathematics, and has a wide range of definitions within literature. One main purpose of STEAM education is to develop students' creativity and problem-solving skills in real-world settings (Herro & Quigley, 2017; OECD, 2019; Perignat & Katz-Buonincontro, 2019). Real-world contexts situate the problem within the STEAM disciplines, allowing the integration of STEM disciplines and Arts, and exploration of STEAM in disciplinary or interdisciplinary ways (Darian-Smith & McCarty, 2016; Herro & Quigley, 2017; Perignat & Katz-Buonincontro, 2019). The level of integration of the STEAM disciplines may vary as some approaches view STEAM as "adding the Arts to STEM" (Perignat & Katz-Buonincontro, 2019, p.38), where Arts (as a synonym for creativity) plays a supporting role to STEM disciplines. Other approaches characterise STEAM education as a fully integrated approach, merging the five disciplines in a transdisciplinary, multidisciplinary or interdisciplinary way (Darian-Smith & McCarty, 2016; Perignat & Katz-Buonincontro, 2019). Learners are encouraged to view the practical applications of their developing STEAM knowledge, skills and attitudes in more relevant, realistic and familiar scenarios, with the aim of engaging and motivating learners (Darian-Smith & McCarty, 2016; Herro & Quigley, 2017). STEAM education often incorporates digital learning, through technology-based activities, digital literacy enhancing activities and creative arts involving digital tools. Alongside this focus on digital learning is the focus on design-based activities in STEAM, often utilising technology in the process (Perignat & Katz-Buonincontro, 2019). STEAM education theory is put into practice through the use of a wide range of context specific teaching approaches (Herro & Quigley, 2017).

Youthreach: Alternative educational provision in Ireland

Alternative educational provision (also known as alternative provision/alternative education provision, AEP) is described internationally as programmes set up by local authorities, schools, communities and voluntary organisations to serve young people whose needs are not being met by the traditional or mainstream learning environment (Gutherson et al., 2011). In Ireland, education is compulsory for students aged 6-16 or until completion of 3 years of secondary education (Citizens Information Board, undated) and Youthreach is the government's main alternative educational provision for early school leavers. Youthreach provides education for young people who leave mainstream education before Leaving Certificate level, sometimes without having completed the Junior Cycle (Smyth et al., 2019). Learners may describe Youthreach as a "last chance" and the Youthreach programme offers them opportunities that were not available in mainstream schooling (McHugh, 2014, p6). Youthreach currently has 112 centres in Ireland serving around 11,000 learners (Smyth et al., 2019). The overall aim of Youthreach is to prepare young people for further education, training and employment (Smyth et al., 2019). To do so, Youthreach centres provide a variety of certified courses including Quality and Qualifications Ireland (QQI) Levels 3 and 4, and the Leaving Certificate Applied (LCA) programme, Junior Cycle and Leaving Certificate programmes (Quality and Qualifications Ireland, 2021). Youthreach centres are afforded a degree of autonomy to choose which courses they offer based on local contexts and learner needs (Smyth et al., 2019).

Youthreach aims to develop young people's knowledge and skills, promote engagement and positive attitudes towards education, improve personal and social skills, increase self-esteem, sense of belonging and purpose in life (Department of Further and Higher Education, Research, Innovation and Science, 2022; Smyth et al., 2019). Youthreach provision benefits from small class sizes and individualised learner support. Teaching and learning in Youthreach aims to use

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a variety of teaching methods where learners work at their own pace. These aspects are key to re-engaging learners in education and promoting positive attitudes towards education (Smyth et al., 2019). However, within Youthreach there are issues around learner non-attendance, which can often be due to difficult home or community circumstances. There are also concerns around high rates of non-completion of accredited programmes (McHugh, 2014; Smyth et al., 2019). Youthreach education emphasises the importance of building positive relationships between staff and learners, and learners note that their positive learning experiences stem from building these relationships with staff. Staff working in Youthreach centres have a range of experience and backgrounds, including industry, craft, mainstream education and youth work (McHugh, 2014; Smyth et al., 2019).

Research aims

Alternative educational provision in Ireland is not clearly defined in literature and policy. In addition, there is a lack of evidence-based research into alternative educational provision in Ireland upon which to make recommendations (Cahill et al., 2020; Smyth et al., 2019). The research presented in this paper is from the implementation of *Full STEAM ahead: A partnership approach to STEAM in Youthreach.* The project aims to support Youthreach staff to implement STEAM education by developing a Framework for STEAM Education in Youthreach. This Framework draws on the perspectives of stakeholders, including professionals with an interest in and working within alternative educational provision in Ireland, and on current literature in the field of STEAM education. The Framework for STEAM Education in Youthreach will be developed through co-creation between researchers and stakeholders over the pilot year of the project. The Framework aims to support the professional learning of Youthreach staff to design and implement STEAM activities with Youthreach learners.

Methods

A qualitative methodology was used to gather and analyse data. Semi-structured interviews were conducted with ten individuals, identified as key stakeholders with an interest or involvement in STEAM education in Youthreach. This included four representatives of national organisations, three Youthreach centre coordinators and three Youthreach educators involved in the pilot project. The participants were asked to discuss their experiences and understanding of STEAM education in Youthreach at the beginning of their involvement in the project. These interviews were conducted by one of the researchers using online meeting software, audio-recorded and transcribed.

Deductive qualitative content analysis was used to analyse interview. Deductive content analysis uses a coding frame (also called a categorisation matrix) to code data according to pre-determined categories (Elo & Kyngas, 2008). The coding frames (Figures 1 and 2) aimed to gather data relating to the proposed Framework for STEAM Education in Youthreach, which focused on four domains:

- STEAM characteristics: The features of STEAM education;
- STEAM learning outcomes: The development of learners' knowledge, skills/life skills and attitudes and values;
- STEAM sessions: The practical aspects of facilitating STEAM in Youthreach
- STEAM Assessment: Assessment and feedback of learning in STEAM.

The characteristics of STEAM can be summarise as: real-world contexts; disciplinary and interdisciplinary learning; problem solving; creativity; design thinking; digital literacy; and appropriate teaching approaches.

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The specific domain is indicated in square brackets after the coding category in Figures 1 and 2

Awareness of STEAM education [characteristics of STEAM]
- *Awareness of the value of STEAM education*
- *Understanding of STEAM Education in Youthreach*

Commitment to maintain STEAM in Youthreach
- *Changes made as a result of involvement in STEAM in Youthreach*
- *Future plans and intentions regarding STEAM in Youthreach*
- *Challenges to STEAM in Youthreach*

Figure 1: *Coding frame for analysis of interviews with national stakeholders*

Plans for STEAM education in Youthreach
- *Skills, knowledge, attitudes of STEAM [STEAM learning outcomes & STEAM assessment]*
- *Accreditation for courses (LCA/QQI) [STEAM sessions]*
- *Teaching and learning approaches [STEAM characteristics]*
- *Life skills [STEAM learning outcomes]*
- *Inclusion of underrepresented groups [STEAM learning outcomes]*

Confidence and concerns for designing, planning, teaching and delivering STEAM education in Youthreach [Educators only]
- *Concerns for designing/planning [STEAM sessions]*
- *Confident about designing/planning [STEAM sessions]*
- *Concerns for teaching/delivering [STEAM sessions]*
- *Confident about teaching/delivering [STEAM sessions]*

Planned links to STEAM industry
- *Learning and awareness of STEAM industry and alternative career pathways [STEAM learning outcomes]*
- *Links with STEAM industries and role models [STEAM learning outcomes]*

Plans for sharing learning
- *Sharing learning within the Youthreach centre*
- *Sharing learning with other Youthreach centres*
- *Sharing learning beyond Youthreach*

Figure 2: *Coding frame for analysis of interviews with Youthreach coordinators and educators*

Findings and discussion

The Framework for STEAM Education in Youthreach was informed by analysis of interviews with participants who have an interest and knowledge of STEAM education in Youthreach contexts, alongside current literature. The participants' first-hand knowledge of alternative education provision in Ireland (Youthreach) supported the development of a more appropriate Framework for designing and implementing STEAM activities in the Youthreach context.

The Framework for STEAM Education in Youthreach identifies STEAM characteristics, STEAM learning outcomes, STEAM session planning, STEAM assessment and feedback.

These aspects were reported in literature (e.g. Herro & Quigley, 2017; Perignat & Katz-Buonincontro, 2019) and observed in interviews with stakeholders.

STEAM Characteristics

STEAM Education in Youthreach is described with seven characteristics (Table 1).

Table 1: *STEAM characteristics and relevant stakeholder quotes*

STEAM characteristic	Quote from stakeholder
a) Real-World Contexts	"We're going to take it locally and very much aim it at a world that they're familiar with." P3.1 Youthreach educator
b) Disciplinary and Interdisciplinary Learning	"There would be a cross with Craft and Design. There will be a cross with health and fitness, there will be a cross with hotel and catering, and there definitely will be a cross with maths, and with technical drawing." P3.1 Youthreach educator
c) Problem Solving	"Taking problems and coming up with solutions and relate them to the real world." National stakeholder (NC-AYRC)
d) Creativity	"Value and recognise the development of skills (problem solving, creativity, digital literacy)" National stakeholder (NC-AYRC)
e) Design Thinking	"Bring in little projects and little kits they can make and do." P3.1 Youthreach educator
f) Digital Literacy	"We're very conscious of the developing digital divide, really, for our young people in the area and beyond." P1.2 Youthreach coordinator
g) Appropriate Teaching Approaches	"Practical, hands-on, collaborative … very specific to the group of learners that I'm working with." P1.1 Youthreach educator

a) Real-world contexts

Learners develop skills and life skills, knowledge and positive attitudes towards STEAM through exploring contemporary, familiar and relevant real-life situations. This approach aims to appeal to learners' interests and motivations (Herro & Quigley, 2017). Learning within real-life and culturally relevant contexts encourages young people to identify the connections between themselves, their communities and society more widely, and connect new and existing knowledge (Caudle et al., 2021). Contexts may be drawn from the United Nations' 17 Sustainable Development Goals (SDGs) which aim to improve the lives of people everywhere (https://sdgs.un.org/goals).

b) Disciplinary and Interdisciplinary Learning

Learners explore new ways of thinking about and organising their knowledge from the STEAM areas. Disciplinary learning focuses on learning about the discrete disciplines of Science, Technology, Engineering, Arts and Mathematics. These disciplines may be combined with increasing complexity from multi-disciplinary to transdisciplinary learning (Darian-Smith & McCarty, 2016). Exploring multiple STEAM disciplines aims to strengthen learning within the disciplines and between disciplines, making explicit connections between them. This can lead to increased interest and engagement with the STEAM disciplines that learners were not previously exposed to (Herro & Quigley, 2017). STEAM Education in Youthreach aims to

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promote learning through exploring contexts with links to at least three of the STEAM disciplines.

c) Problem solving

Problem solving in STEAM education is a collaborative process where learners work together to develop and use their STEAM knowledge, skills/life skills, and attitudes and values to solve a problem set in a real-world context. Learners are encouraged to seek out and identify problems, and work together to find solutions. The emphasis is on the process, rather than the final outcome or product (Perignat & Katz-Buonincontro, 2019).

d) Creativity

Creativity is often associated with the "A"/arts within STEAM (Perignat & Katz-Buonincontro, 2019). The Framework for STEAM Education in Youthreach emphasises that creativity is inherent within and adds value to all disciplines of STEAM. The focus is on developing creative habits of mind: Collaborative, inquisitive, persistent, imaginative, disciplined (Thomas Tallis School, undated).

e) Design thinking

Design thinking is when learners use their creativity to solve real-world problems, following a five step process where learners empathise, define, ideate, prototype, and test their designs (Henriksen, Mehta & Mehta, 2019). Similarly to collaborative problem solving, the focus is on the process and skills development rather than the final outcome or design.

f) Digital literacy

In STEAM Education in Youthreach, digital tools are used to support teaching and learning and to encourage active involvement in the learning process. Learners use technology to engage in learner-centred inquiry and design processes to explore real-world problems. The aim is for learners to develop a range of digital literacy skills to support their learning, life and future careers (Department of Education, 2022). These skills relate to: proficiency in use of digital technology, communication tools and the internet; creating digital content and file management; communication and collaboration; and awareness of safety and environmental impact of digital technology (Vuorikari et al., 2016).

g) Appropriate teaching approaches

Appropriate teaching approaches for alternative education settings are a key characteristic of STEAM Education in Youthreach. The aim is to promote the empowerment of young people in relation to their learning and positive experiences for young people whose needs may not have been met by the mainstream learning environment (Cahill et al., 2020; Gutherson et al., 2011). At the centre of STEAM education in Youthreach is a learner-led approach which promotes young people having the space to express a view (space), be supported to express their views (voice), have their views listened to (audience) and have their views acted upon (influence) (Lundy, 2020). Teaching and learning approaches are broad ranging to suit the needs of learners and include inquiry-based learning, problem-based learning, project-based learning, designing and making (with focus on process and product), direct instruction/ teaching, collaboration and teamwork, authentic learning activities (field trips, visits from experts/industry) and work experience (Smyth et al., 2019).

STEAM learning outcomes

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STEAM learning outcomes refer to the knowledge, skills/life skills, and attitudes and values that learners in Youthreach develop through their involvement in STEAM education. STEAM learning outcomes is the term preferred by Youthreach staff due to its use in the specification documents for the courses they teach. The term is used in the Framework synonymously for learning goals, learning objectives, learning intentions, goals or aims (Allan, 1996). Allan (1996) describes learning outcomes as "broad overarching consequences of learning" in terms of "what a learner knows or can do" (p.99).

The Framework for STEAM Education in Youthreach promotes the development of knowledge, skills/life skills, and attitudes and values of STEAM. These are developed interdependently, through the mobilisation of knowledge, skills, attitudes and values within specific real-world contexts as competences/competencies (OECD, 2019). Knowledge, skills, and attitudes and values include foundational learning on which further learning depends, such as literacy and numeracy, health/wellbeing literacy, and social, ethical and emotional literacy (OECD, 2019).

Table 2: *STEAM learning outcomes and relevant stakeholder quotes*

STEAM learning outcomes	**Quote from stakeholder**
a) Knowledge	"Teaching them the history of photography." P2.1 Youthreach educator
b) Skills	"All the life skills that go around working collaboratively … teamwork and group cohesion. But then also linking the 3D print stuff to industry and considering further employment opportunities and skills for on the job." P1.1 Youthreach educator
c) Attitudes and values	"Maybe change their attitudes towards STEAM that they may hold from traditional schooling. Most think they don't understand math … to really see that they actually have those skills." P2.2 Youthreach coordinator

a) Knowledge

In the Framework for STEAM Education in Youthreach, knowledge is defined as the established concepts, facts and figures, ideas and theories about the world (OECD, 2019). Knowledge is mobilised by learners alongside skills and attitudes and values in the performance of competencies to meet complex demands (OECD, 2019). There are different types of STEAM knowledge: content knowledge, and procedural knowledge (OECD, 2019). Content knowledge is theoretical knowledge which includes understanding of concepts and ideas of STEAM. In STEAM education in Youthreach, knowledge may be disciplinary, relating to one of the STEAM subjects, or span multiple disciplines (Darian-Smith & McCarty, 2016). Disciplinary knowledge includes subject-specific concepts and content. Interdisciplinary/multidisciplinary knowledge encourages learners to relate the concepts and content of one STEAM discipline to the concepts and content of another (OECD, 2019). Procedural knowledge, sometimes known as practical knowledge, is based on learners' experience and practice of activities and is the understanding of how something is done. This knowledge type can also be discipline specific or interdisciplinary (OECD, 2019).

b) Skills

STEAM Education in Youthreach aims to support learners to develop a range of skills, which are the ability and capacity to responsibly carry out processes and use knowledge to achieve a

goal. Skills are mobilised alongside knowledge and attitudes and values as competencies (OECD, 2019). STEAM skills include cognitive and metacognitive (learning about learning) skills, social and emotional skills, and physical and practical skills. These different types of skills work together to allow learners to be successful in their education, future learning, careers and life (OECD, 2019). In STEAM education in Youthreach learners develop discipline specific skills relating to one aspect of STEAM. Learners may then apply these skills in interdisciplinary STEAM contexts spanning multiple STEAM disciplines. STEAM education in Youthreach also encourages learners to develop transdisciplinary skills such as those related to creativity and problem solving (Herro & Quigley, 2017; Perignat & Katz-Buonincontro, 2019). These are often referred to as life skills or life skills within the Youthreach context.

c) Attitudes and values

STEAM Education in Youthreach aims to positively influence learners' attitudes and values, which are the principles and beliefs that influence the learner's choices, judgements, behaviours and actions (OECD, 2019). Combining the various disciplines of STEAM learning and focusing on real-world contexts increases learner interest, engagement and motivation towards STEAM (Herro & Quigley, 2017). The following actions aim to promote the development of positive attitudes and values towards STEAM within the Youthreach context:

1. Facilitating learners to engage in diverse and inclusive STEAM learning experiences through a range of pedagogical approaches;
2. Encouraging learners to recognise and understand their existing attitudes and values, known as dispositions, and understand the context in which these were formed;
3. Promoting learners' STEAM identities including feeling a positive connection with STEAM and that STEAM is 'for me';
4. Fostering positive attitudes towards the different aspects of STEAM by highlighting their use and relevance in everyday life and potential careers;
5. Enable learners to use their STEAM learning to benefit themselves and their communities;
6. Enable learners to appreciate ethical aspects of STEAM.

(Cahill et al., 2020; Gutherson et al., 2011; Lundy, 2020; OECD, 2019)

STEAM sessions

This aspect of the Framework provides practical resources for planning STEAM education activities in Youthreach. It includes scheme and session plan templates to guide Youthreach staff. The templates were based on the Framework and the needs of Youthreach staff as expressed during piloting of this project.

STEAM assessment

Assessment approaches for STEAM Education in Youthreach aim to assess the development of knowledge, skills/life skills, and attitudes and values STEAM learning outcomes. Assessment approaches aim to gather evidence of learning and provide opportunities for effective feedback to support learning (Black & Wiliam, 2010). However, skills and attitudes and values are often harder to measure than content knowledge. Determining the impact of learning activities in STEAM on the learners' skills, life skills, and attitudes and values in STEAM education in Youthreach can be challenging (Perignat & Katz-Buonincontro, 2019; Smyth et al., 2019). The methods of assessment aim to reflect the purpose, principles and values of Youthreach, which emphasises personal development and core skills (Department of Further and Higher Education, Research, Innovation and Science, 2022). Assessment in STEAM

education in Youthreach may be summative or formative. Summative assessment is a judgement of achievement, usually for the purpose of reporting. It is often conducted at the end of the learning, such as a final exam, portfolio or other format (Black & Wiliam, 2010). In Youthreach, summative assessments such as tests or exams are conducted "occasionally" (Smyth et al., 2019).

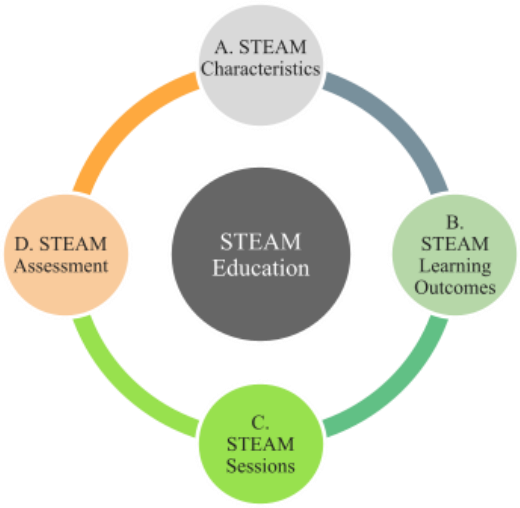
Formative assessment is assessment for the purpose of supporting learning. Formative assessment aims to make learning visible to the educator and to the learner, and gives the learner opportunities to improve (Black & Wiliam, 2010). There are various ways that formative assessment may be carried out in STEAM education in Youthreach. Examples of evidence gathered may include practical work and project work, written work, classroom dialogue, interviews, observations, learning portfolios, product designs, multimedia presentations, peer and self-assessment feedback (Smyth et al., 2019). Once evidence of learning has been gathered, it is important that learners receive formative feedback about their learning and how to improve further. Feedback is critical to improving learning as it increases learners' motivation and their ability to learn and may come from the educator, peers or the learner themselves (Black & Wiliam, 2001). STEAM education in Youthreach promotes the practice of regular feedback to promote the development of knowledge, skills/life skills and attitudes and values of youthreach learners.

Conclusions & Implications

This study presents the approach adopted to design a Framework for STEAM Education in Youthreach, developed from the implementation of the project *Full STEAM ahead: A partnership approach to STEAM in Youthreach.* The Framework builds upon the perspectives of stakeholders and current literature to propose an appropriate Framework for implementing STEAM education in the Youthreach context in Ireland.

The Framework (shown in Figure 3) identifies characteristics of STEAM; STEAM learning outcomes relating to knowledge, skills/life skills, attitudes and values; STEAM session planning; and STEAM assessment and feedback. The Framework aims to support the implementation of STEAM education in alternative education provision in Ireland. This will work towards promoting the engagement of learners who are often excluded from STEAM learning and careers, by developing their knowledge, skills/life skills, and attitudes and values of STEAM.

Figure 3: *Towards a Framework for STEAM Education in Youthreach*



The Framework will be further developed in the next phase of this project and informed by follow-up interviews with the participants in this study and other key stakeholders (e.g., Youthreach learners, project partners). Participants' experiences of designing and implementing STEAM activities will be discussed in relation to the Framework for STEAM Education in Youthreach. This will allow continued development of the Framework to align closely with the innovative and emerging field of literature regarding STEAM education and the implementation of STEAM education within Youthreach alternative education provision in Ireland.

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