STEAM Stars

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IO1/A2: Analysis of the Context and Professional Practice

Literature Review

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Introduction

The STEAM Stars Project

The STEAM Stars project aims to design a European Framework of Competences in teaching STEAM education for gifted students. It will promote innovative methods and pedagogies focused on high achieving students, and develop OER digital learning materials and tools in STEAM education for gifted students.

It is clear that there is a need across Europe to improve educational practices and activities aimed at these students, influenced by the scarcity of targeted teacher training in this area. Currently, most gifted children spend the majority of their time in regular classrooms without access to challenging coursework or teachers knowledgeable about the special learning needs of our most highly able learners. That is the reality in countries like the UK, Ireland, Spain, the Netherlands and Turkey.

STEAM education has enormous potential to provide more challenging and motivating exercises to gifted and talented students. We can define STEAM education as Science and Technology, interpreted through Engineering and the Arts, all based in Mathematical elements. STEAM is not about spending less time on STEM subjects and more time on art: rather, it is about applying creative thinking to STEM projects, and sparking students' imagination and creativity through the arts. Studies show that a quality STEAM education program is engaging, motivating, student-centred, innovative, collaborative, and has real-world applications.

Despite a significant level of interest in STEAM, it is often challenging for teachers to integrate it into their teaching within the curriculum. To help gifted students achieve STEAM excellence is necessary to: identify the competences that teachers need in order to provide challenging material to the most capable learners; train teachers to recognise giftedness; incorporate into teacher training the educational use of ICT and the encouragement of creativity, innovation and initiative; create specialised and innovative training and assessment methods, contents and tools in STEAM education for gifted students to support the professional practices of the teachers; and expand the number of selective schools in Europe that apply STEAM education for gifted students.

The envisaged long term impact of the project will be a strengthening of the School Education system in Europe.

Intellectual Output 1: Activity 2

The first output of the STEAM Stars project is the development of an innovative European Framework of Competences in teaching STEAM education for gifted students. This Framework will define, for the first time, the competencies, knowledge and skills required to teach STEAM for this target group. The EFR will be designed following European frameworks

of reference, such as the EQF and ECTS, in order to facilitate the recognition and validation of learning outcomes and foster mobility in Europe.

This output reports on a review of relevant literature undertaken in order to provide an analysis of the context and professional practice. The results of this review contribute to the identification of competences used in the construction of the European Framework of Competences.

Review of the Literature

The literature search was conducted using resources including Coventry University's library catalogue, ERIC (Education Resources Information Center), SCOPUS, and Google Scholar. A range of terms was used in order to locate publications using different terminology; for example, descriptions of students included "high achieving", "gifted", and "talented".

The review is divided into three categories, though there is some crossover between them, as will be made clear in the following sections.

Characteristics of Gifted Students

The characteristics of gifted students can be a useful lens through which to focus expectations; in many cases these individuals have needs and traits which teachers must recognise and understand in order to support and challenge them.

Betts and Neihart (1988) developed six profiles of gifted and talented children, based on observation, interviews, and literature reviews. They created a matrix to assist parents, teachers, and other relevant adults to understand the nature and needs of those six types of young people, and to enable them to identify the different ways in which gifted children present.

The six profiles identified by Betts and Neihart are:

I. Successful ("plays the game"; works with the system; might be (seen as) lazy because they don't have to try too hard)
II. Challenging (divergently gifted; difficult to identify; often questioning of authority, and disruptive)
III. Underground (denies their talent)
IV. Dropouts (angry; rejected; resentful)
V. Double-labelled (has a physical/emotional/learning disability; talent can be hard to identify as a result)
VI. Autonomous Learner (self-facilitator; uses the system; successful).

The matrix presents each profile, together with a list of characteristics, categorised by: feelings and attitudes; behaviours; needs; adults' and peers' perceptions of the type; identification; home support; and school support.

Betts and Neihart quote Strang (1962), who wrote that "the gifted cannot be seen as one group", and they acknowledge that no single child or young person could fit perfectly into any one of their profiles. Further, they note that it is unlikely that anyone would settle into just one type until they reached adulthood, and even then some people will fit into more than one type.

Betts and Neihart's profiles considered the ways in which gifted children present themselves to others. In comparison, Annemarie Roeper's (1982) list of characteristics of gifted children focuses on how they cope with their emotions.

Roeper's article focuses on the importance of including emotions within the overall view of a gifted child. She notes that emotions, intellect, and physical development are all intertwined and combined within a gifted child, and all have an influence. She writes that "[a] gifted child's emotions and intellect are different from those of other children his age; they are not ahead or advanced." (p. 21)

Roeper also identified six categories, or 'types', characterised by "some common approaches gifted children choose to cope with their emotions." (p. 21).

The Perfectionist: Failure is not permitted. The child has a sense of omnipotence, and resultant guilt due to not meeting their (perceived) responsibilities. The perfectionist will have underdeveloped emotions, possibly including suppressed aggression which can manifest as masochism (self-harm, etc.).

The Child/Adult: This type perceives themself as an adult, can appear to be an underachiever due to a lack of respect for adult authority and not seeing other children as peers. The child/adult has an unconscious need to be in charge – a lack of trust in the world.

The Winner of the Competition: This child is in (perceived) competition with a parent (Oedipal aspects). Again, a sense of omnipotence leads to a sense of superiority and a desire to compete constantly; this can lead to internal conflict due to cognitive dissonance.

The Exception: In these children, the feeling of omnipotence leads to a lack of empathy with others. They may consider themselves to be "beyond the system", showing a high level of superiority. They are not competitive because "normal expectations do not apply to them" (p. 23).

The Self-Critic: This child has a compulsion to repeat tasks in order to check and recheck. They do not believe in their own giftedness, but only in their responsibilities.

Well-Integrated Child: These children are realistic; they are aware and tolerant of failure. They have high levels of awareness of wider problems, are supported by their family, and have a developed sense of empathy.

The feeling of omnipotence which Roeper highlights, which is so problematic with regard to the management of emotions, could also contribute to high levels of boredom and "malnourishment" among gifted children in the classroom. Tracy Cross (2014) believes, based on 30 years' experience of working in the field of gifted education, that "the single

greatest threat to the psychological well-being of gifted students is the mismatch between the school's curriculum and the student's needs" (p. 264). Cross argues in this opinion piece that gifted students are chronically malnourished by their educational experiences and that this has a negative impact on their psychological wellbeing. "Developing the potential of young students into specific talent domains requires constant challenge, opportunities to fail, and practice – lots and lots of practice." (p. 265).

Gifted students who are educationally malnourished for an extended period commonly react to the resultant chronic boredom by disinterest, underachievement and fatigue. This can also lead to these students leaving school without completing their studies, and therefore living the rest of their lives without being challenged and without reaching their potential. Cross calls for an acknowledgement of the importance of beneficence (kindness, benevolence, generosity) in education, and a commitment to the educational nourishment of all students, including those who are gifted.

He believes that in order to create nourishing educational environments, practices such as "appropriate grouping, out-of-level assessment, [and] acceleration opportunities" should be used (p. 265). Cross references Kanevsky and Keighley (2003) who define five characteristics of effective learning environments to engage gifted students: a caring teacher, complexity, challenge, control, and choice (see below).

Kanevsky and Keighley's article investigates boredom factors for gifted high school students in Canada. They focused predominantly on students who were "nonproducers", choosing not to attend classes or complete assignments because they considered them to be boring or irrelevant. These students are at risk academically but not psychologically.

Similar to Cross, Kanevsky and Keighley believe that boredom is a significant factor in both lack of achievement and challenging behaviour in gifted students. They note that "boredom is chaotic and dynamic" and is a "pervasive features of gifted students' school experience" (p. 21).

They interviewed students aged 15-18 who had been identified as gifted in primary school, were currently underachieving academically, and had been suspended or dropped out of school at least once. They found that the students equated boredom with "schooling", which was "teacher-directed, textbook-based, and addressed content students already knew" (p. 22), while "learning" was not boring – as long as it had five specific features. The extent to which the five Cs – control, choice, challenge, complexity and caring – were present in a learning exercise determined whether or not the student was bored or engaged. These features are examined more in the next section.

The overarching conclusion reached by Kanevsky and Keighley was that, for gifted students, "boredom and learning were mutually exclusive: they were never bored when they were learning and were never learning when they were bored." (p. 25). Boredom led to indifference, to misbehaviour, and – perhaps most damagingly – to frustration.

Teaching Gifted Students

The "five Cs" identified by Kanevsky and Keighley (2003), which they believed would determine whether or not a gifted student would engage, and therefore succeed, in the classroom, are outlined briefly below.

Control: Self-determination, the power to change the situation, and the authority to implement their choices. One of the students interviewed said, "you have to jump through hoops and I don't want to. I want to make my own hoops." (p. 23).

Choice: Closely linked to control – students felt that their ability to make decisions was not respected by adults in the school, and so they chose not to produce the work that was expected.

Challenge: This had different meanings to the study's participants, as it does within the literature, but gifted students tend to find that textbook-based learning is the opposite of a challenge. A lack of academic challenges can lead to challenging behaviour on the part of the gifted student. The students wanted a differentiated curriculum which allowed them to move ahead, increase complexity, and reduce repetition.

Complexity: High-achieving students "craved the unfamiliar" (p. 24). Repetition, memorising, and copying information was boring. Some of the respondents suggested that studying a topic for longer would lead to more complexity and thus to more interest. The students preferred to work at a self-determined pace, and finding challenge in, for example, digging deeper into a subject.

Caring: A caring teacher was extremely important to the gifted students – someone who clearly wants to teach, who listens, and who inspires and returns respect and reciprocity. Words used to describe caring teachers included non-judgmental, fair, flexible and humorous; they used a variety of techniques and media to teach, using discovery, inquiry-based and hands-on methods. A willingness to listen and engage in dialogue with students was also important.

The students who were interviewed by Kanevsky and Keighley were not unsympathetic to their teachers' difficulties in meeting the educational needs of students with a range of abilities. However, their empathy could not overcome their boredom and frustration. "One of the rights these students held sacred regarding their education was the equal opportunity to learn. Why wasn't there as much learning for them in school as there was for other students?" (p. 26).

Kanevsky and Keighley conclude that

> "educators need to: (1) ask students about *their* boredom, (2) *listen* and probe until their understanding is deep and accurate, and then (3) *act* on what they hear" and also should "weave opportunities for personal control, choice, challenge and complexity into classroom activities". (p. 27).

While Kanevsky and Keighley present a number of suggestions with regard to supporting and challenging gifted students within the classroom, they stop short of directly addressing how teacher education programmes address the needs of these individuals. In contrast, Reid and Horváthová's 2016 paper 2016 reviews gifted education in Slovakia, Austria, Belgium and Finland, and describes teacher training programs and qualifications for teachers of gifted pupils in those countries.

At the time of writing the article, only 9 countries within a selection of 21 European countries provided training for teachers working with gifted pupils. Reid and Horváthová conclude that "despite the great attention provided to the education of gifted pupils, the education of teachers of gifted learners has been neglected." (p. 71). They note that of the four countries studied, only Austria had an established system for training teachers for gifted learners. Although Finland did not have specific gifted education its education results had been among the best for some time – probably because its education system is "based on individual approach to learners, which is one of the specific features of working with gifted learners." (p. 71).

Reid and Horváthová suggest that all teacher training institutions should include courses on "giftedness, peculiarities of gifted children, principles on working with the gifted, etc.", and should also include training in didactics, which often includes pupils with special educational needs but excludes those who are gifted. Teachers need to be able to "shift from the traditional approach towards the more constructivist approach and to adapt to differences of gifted children" (p. 71).

In comparison, Dixon et al. (2004) focus on the use of a dialectical method of teaching for gifted students, reporting on the results of a study in which a class of gifted 9-11 year old pupils were taught using the Dixon-Hegelian method. This framework has an emphasis on allowing the students to do "what they do best: think critically" (p. 59). The teacher, rather than leading and dominating discussions, "lays the groundwork and teaches the process for productive discussion – and then trusts it" (p. 63).

Dixon et al. conclude that teachers should "create opportunities for students to think all the time" (p. 74) – to guide and listen, and thus to foster self-efficacy in the pupils. The Dixon-Hegelian method creates a framework within which this can occur. "The notion that teachers of the gifted do not need to teach these students to think, but, rather, must teach to the students' thinking must not be taken lightly." (p. 74)

Charles Pope Rossier, writing 45 years earlier of his experiences teaching English to a class of gifted students, also believed that in the importance of creating opportunities for students to contribute and think critically within the classroom. He stated that a course for gifted students

> not only must offer a greater *amount* of subject matter but also, and even more important, it should contain a different *kind* of material […] it should certainly differ in depth. That is, it should require of the students greater perception, greater appreciation, and more mature emotional responses than could (or should) be expected of average teen-agers. (1959, p. 415)

Rossier took into consideration the criticisms made by his students, making changes to his curriculum each year as a result. He vastly reduced the number of "visual aids" such as slides and increased the opportunities for students to create their own presentations, finding that they were of benefit not only to the student who researched and prepared them, but also to their fellow learners. "I learned that it is desirable to give each student a sense of mastery in a certain area; it contributes to pride in his own accomplishment and to status in the eyes of his classmates." (p. 416)

An additional consideration when teaching gifted students is the "often forgotten factor" of introversion (Burruss and Kaenzig, 1999). Introverts are, according to their research, "a minority in the regular population but a majority in the gifted population" and the characteristics of these individuals should be taken into account when educational and parental support strategies are being developed.

Introverts are primarily focused on their internal world; they "get their energy from themselves and are drained by people" while extraverts get their energy from others. As a result it can be difficult for an extravert to understand an introvert, and if a teacher is an extravert (which Burruss and Kaenzig believe is true of most teachers) it can lead to problems in supporting and teaching them. Identifying a gifted student as being an introvert (and vice versa) can be hard; the characteristics may be similar (self-sufficiency, confidence, self-actualising) or very different (withdrawn, low self-image). Methods suggested by Burruss and Kaenzig include "independent studies, small group instruction, collaborative learning activities", which is similar to some of the research reported above; they also suggest that introverted students prefer lectures and exposition on the part of their teachers, which is not. Once again, this research illustrates the importance of a high degree of flexibility on the part of teachers in understanding and engaging these students.

Teaching STEAM to Gifted Students

There is less literature to be found on the topic of teaching STEAM to gifted students than on teaching STEM (science, technology, engineering, and maths). This is not surprising since there has been a focus, particularly in the UK, on improving learning in the more scientific subjects over the past decade or so, and on encouraging girls and young women into these subject areas.

This does not mean that literature focused on teaching STEM to gifted students cannot be useful in the development of STEAM education; there has been a great deal of research into the integration of arts teaching into the more quantitative, science-focused subject areas.

Robert J Sternberg (2019) discusses "the application of an augmented theory of successful intelligence to identification, teaching, and assessment of the gifted in STEM disciplines" (p. 103). He begins by noting that many of the principles discussed in the article apply to all students, not only to those who are gifted.

> The challenge of teaching gifted students is to accelerate and at the same time enrich their learning so that the students are constantly challenged and, hopefully, never bored. But at the same time, good teaching is good teaching, and all learners need to apply the same sets of skills to learning (p. 104).

Sternberg comments that science is largely a self-directed activity, but is taught in an "other-directed" way, often using memorisation, learning facts by rote, and so on, and as a result autonomous learners, who are naturally self-directed, may be less successful than those who simply want to be told what to do.

Sternberg's augmented theory of successful intelligence "suggests that many students' failures to achieve at a level that matches their intellectual potential often results from teaching and assessment that are narrow in conceptualization, rigid in implementation, and inappropriate for the subject matter being taught (Sternberg, 2012, 2017)." (p. 105). Gifted students are "legislative stylists – people who like to come up with their own ideas – whereas schools tend to reward executive stylists – people who like to be told what to do." (p. 105).

Successful intelligence is (in a nutshell) the ability to use one's strengths, abilities and attitudes in order to achieve happiness and success within one's own sociocultural context; also, therefore, knowing one's weaknesses and how to correct or compensate for them. It requires adaptation and finding a balance among all of the skills and abilities possessed by an individual. Sternberg advocates for an integrated and balanced curriculum – for arts and science to be taught together.

Hope Wilson's (2018) article reports on an analysis and review of 61 lessons in STEAM by experts in related fields. Similar to Sternberg, Wilson believes that STEAM initiatives can have particular significance for gifted students, who are "more able to make connections

across disciplines due to their increased intellectual and academic capabilities" and because "gifted programs are often designed to develop critical and creative thinking skills" (p. 108).

Wilson states that STEAM has the "potential to develop creative problem solving, individual learning, and social responsibility […] by engaging students in high-level thinking and synthesizing meaningful content across disciplines." (p. 109). She also notes that the visual-spatial abilities which are used in engineering and in many arts disciplines are often ignored in the identification and teaching of gifted students.

High quality STEAM lessons were identified by the reviewers and themes included: collaboration between teachers, clear criteria for assessment, connections between content areas (interdisciplinary and cross-disciplinary), the need for deep thinking and understanding on the part of the students, opportunities for student reflection, capacity for creativity and use of imagination, and student collaboration.

Conclusion

This literature review was part of the groundwork for the development of a framework of competencies to be used within the STEAM Stars project. The education of students described variously as gifted, high-achieving, and talented has been a topic of research and discussion for many years. Less work has been done specifically regarding STEAM education, but it is clear from the literature summarised within this report that the combination of scientific and artistic or humanities subjects can be particularly valuable for these students, who may be educationally malnourished (Cross, 2014) or detrimentally bored (Kanevsky and Keighley, 2003) by traditional teaching methods.

The first step towards creating a challenging and supportive educational environment for gifted students is to understand some of the characteristics possessed by them as individuals. These characteristics are not universal, and they may present in different ways, depending on the family background and educational history of the student.

Within the context of the classroom, traditional teaching methods can be damaging to the current and future potential of the individual; challenge, complexity, and critical thinking are essential elements for educating the gifted. Flexibility on the part of the teacher is fundamental to meeting the needs of these students; creating a positive classroom environment for all students, while providing challenging and engaging learning experiences for those who are high-achieving.

STEAM education – twining together science, technology, engineering, and mathematics education with arts subjects – is something which could be particularly important to gifted students and their teachers. STEAM has significant potential, through engaging students in creative thinking and problem solving, and providing the opportunity for cross-disciplinary reasoning and reflection, to be an effective and innovative tool for teachers of gifted students.

References

Betts, G.T. and Neihart, M. (1988) 'Profiles of the Gifted and Talented'. Gifted Child Quarterly [online] 32 (2), 248-253. DOI: 10.1177/001698628803200202

Burruss, J. and Kaenzig, L (1999) 'Introversion: The often forgotten factor impacting the gifted'. Virginia Association for the Gifted [online] 21 (1). available from <https://www.davidsongifted.org/search-database/entry/a10274> [6 August 2020]

Cross, T. L. (2014) 'Social Emotional Needs: The Effects of Educational Malnourishment on the Psychological Well-Being of Gifted Students'. Gifted Child Today 37 (4), 264-265

Kanevsky, L. and Keighley, T. (2003) 'To produce or not to produce? Understanding boredom and the honor in underachievement'. Roeper Review [online] 26 (1), 20-28. DOI: 10.1080/02783190309554235

Reid, E. and Horváthová, B. (2016) 'Teacher Training Programs for Gifted Education with Focus on Sustainability'. Journal of Teacher Education for Sustainability [online] 18 (2), 66-74. DOI: 10.1515/jtes-2016-0015

Roeper, A. (1982) 'How the Gifted Cope with Their Emotions'. The Roeper Review [online] 5 (2), 21-24. available from <http://www.positivedisintegration.com/Roeper1982.pdf> [9 May 2020]

Rossier, C. P. (1959) 'Teaching English to Gifted Students'. The Clearing House [online] 33 (7), 415-417. available from <https://www.jstor.org/stable/30190933> [12 May 2020]

Sak, U. (2004) 'About Creativity, Giftedness, and Teaching the Creatively Gifted in the Classroom'. Roeper Review [online] 26 (4), 216-222. DOI: 10.1080/02783190409554272

Schneider, M (2015, 5 January) *6 Types of Giftedness* [online] available from <https://upcoaching.nl/6-types-giftedness/> [8 May 2020]

Sternberg, R. J. (2019) 'Teaching and assessing gifted students in STEM disciplines through the augmented theory of successful intelligence'. High Ability Studies [online] 30 (1-2), 103-126. DOI: 10.1080/13598139.2018.1528847

The Davidson Institute: https://www.davidsongifted.org/ [4 August 2020].

Tüzün, U. N. and Tüysüz, M. (2018) 'STEAM Education for Teachers of Gifted Students'. Turkish Journal of Giftedness and Education 8 (1), 16-32

Wilson, H. E. (2018) 'Integrating the Arts and STEM for Gifted Learners'. Roeper Review [online] 40 (2), 108-120. DOI: 10.1080/02783193.2018.1434712