

Interdisciplinary Learning: Addressing the Implementation Gap

Julie Harvie
University of Glasgow

ABSTRACT

Interdisciplinary learning (IDL) features heavily within Scotland's Curriculum for Excellence and is promoted as a way to develop skills building and conceptual creativity in students, factors which are now seen as crucial for the twenty-first century education system (Khadri, 2014; Kolmos, 2016). Recent studies suggest, however, that although teachers welcome the idea of IDL in principle, there is a serious policy implementation gap (Harvie, 2018, Graham, 2019). While it is recognised that the structure as well as the culture of organisations can hinder policy enactment (Thorburn, 2017), this article focuses on the issue of conceptual clarity as a barrier to implementation and aims to address this by considering an epistemology and conceptual framework through which IDL can be better understood. Factors which promote IDL are explored along with examples of practice which match the conceptual model. A structure for planning IDL tasks is also suggested with the intention of opening discussion around this topic and providing teachers with practical ideas.

KEYWORDS: interdisciplinary learning, integration, curriculum, problem-based approach

INTRODUCTION

Over the past few decades, global institutions such as the Organisation for Economic Cooperation and Development (OECD) have helped homogenize education policy and similarities can now be seen in curricula across the globe (Priestley, 2002; Sahlberg, 2007). One trend which features in many new curricular models is that of providing students with opportunities to blur disciplinary boundaries. Within Scotland's *Curriculum for Excellence* (CfE), this trend has been reflected with the introduction of 'Interdisciplinary Learning' (IDL) (Sinnema & Aitken, 2013). CfE has named IDL as one of the four contexts of learning alongside

- curriculum areas and subjects, ethos and life of the school and opportunities for personal achievement. The centrality of IDL in the curriculum is underpinned by the premise that we now require a knowledge economy which produces workers with adaptability who are capable of responding to rapid change in the job market (Her Majesty's Inspectorate of Education {HMIE}, 2009). It could be said that in preparing students for life in the post-industrial information age, the "what" that students require to know has now changed (Virtue *et al.*, 2019). IDL is promoted as something which allows educators to facilitate this change and a vehicle to enable students to develop the transferrable, problem solving and generic skills which will equip them for a future beyond the school gates (HMIE, 2009: Education Scotland, 2020). It has been linked with enhancing higher order, critical and holistic thinking (i.e. the ability to understand how ideas and information from relevant disciplines relate to each other). Many argue that this is an engaging and powerful strategy that leads to sustained and transferable learning (Hiebert *et al.*, 1996: McPhail, 2018).

Baumfield and colleagues found that, in all sectors of the Scottish school system, "The promotion of interdisciplinary learning within the Draft Experiences and Outcomes were generally welcomed in principle" (Baumfield *et al.*, 2010:11). This study suggests that, while secondary teachers find IDL harder to comprehend and implement, due in part to the nature of the disciplinary domains and subject-based settings they inhabit, primary practitioners seem more secure about using this approach. However, Harvie (2018) concluded that primary teachers were also unclear about what IDL actually involves and what is referred to, as interdisciplinary practice is often a form of topic work using a theme as a context for teaching the discrete disciplines. Indeed, it was acknowledged by Graham (2019) that IDL has been poorly articulated, poorly exemplified and often poorly understood by teachers even though it is at the heart of the Scottish Curriculum (Shelley, 2019). This is a sentiment echoed by the more recent Advice Paper published by the Royal Society of Edinburgh (2020). In line with The Refreshed Narrative of CfE (Education Scotland, 2019), this Advice Paper advocates the need to support IDL practices in schools but states that a key barrier to embedding it is "...a lack of understanding as to what it is" (p1). This points to a serious implementation gap with regards to interdisciplinary policy i.e. a failure of transference from policy to practice (Supovitz and Weinbaum, 2008) as a direct result of conceptual opacity. It also implies that the claimed benefits of IDL are not being realised in the classroom.

This paper is located within a pragmatic constructivist paradigm and it will be argued in this article that this epistemology is a suitable one for considering interdisciplinary matters. Boix-Mansilla (2010) asserts that because IDL is primarily concerned with the integration of knowledge forms (disciplines) that align to different epistemologies (e.g. methods of analysis, pedagogy, units of measure etc.), in order to better comprehend interdisciplinarity we need a strong epistemological foundation. Such an epistemology has to be able to take account of the many and varied activities and forms of knowledge that IDL can involve. As well as considering an appropriate epistemology, the nature of interdisciplinarity will be examined using the academic literature and a conceptual framework for practice presented. Some pedagogical approaches to planning IDL will then be

considered and factors which can help to facilitate this type of activity. Finally, some suggestions will be given to offer examples of how IDL tasks could be crafted in the classroom.

INTERDISCIPLINARITY AND INTEGRATION

In the United States, the terms ‘integrated’ or ‘integrative learning’ are often used to represent what is referred to elsewhere as ‘interdisciplinary learning.’ Lake (1994) claims that the terms ‘integrated curriculum’ and ‘interdisciplinary curriculum’ are practically synonymous. Central to both is the idea of students exploring knowledge in various disciplines which relate to certain aspects of their environment, cutting across traditional educational boundaries and synthesising disciplinary insights. The focus on ‘integration’ as being core to interdisciplinary activity has resulted in some scholars now being referred to as ‘integrationists’ (O’Rourke *et al.*, 2015). Boix-Mansilla (2017) asserts that what differentiates interdisciplinary approaches from disciplinary or multi-disciplinary ones is the integration or synthesis of knowledge which takes place. Integration is embedded in the whole investigative, interdisciplinary process and is not just an end product (Holbrook 2013). In this article, therefore, the terms interdisciplinary learning and integration will be used synonymously.

EPISTEMOLOGY FOR CONSIDERING IDL

Curriculum integration can be considered a view of the nature of knowledge which holds that all knowledge is somehow whole or can be unified within certain broad fields of experience (Pring, 1971). Newman’s (1873) ‘circle of knowledge’ provides an example of such a view where each discipline is seen to occupy a particular part of the circle and can only answer questions relevant to its own particular field. To gain a holistic education, Newman argued that one had to be familiar with the whole circle and that to acquire a true understanding of reality, engagement with a variety of disciplines is necessary. Integrationists believe that it is possible to use knowledge from different disciplines simultaneously to gain a deeper understanding of reality. However, the study of interdisciplinary practices requires a strong epistemological foundation. IDL can be diverse and cover a host of activities and disciplines. The knowledge involved in designing an historical monument, for example, would contrast substantially with that involved in addressing issues of climate change. There are four elements worth highlighting when considering an epistemology for IDL (Boix-Mansilla, 2017):

1. *Pluralism* – the epistemological framework should be able to account for multiple forms of disciplinary understanding on their own terms
2. *Relevance* – the framework should be relevant to the phenomenon of IDL and illuminate the processes of interdisciplinary integration
3. *Explanatory* - it must take account of how knowledge advances and shed light on the essential dynamics of learning
4. *Quality assurance* – it should be a framework which puts forth robust and relevant standards of acceptability across interdisciplinary endeavours

A pragmatic constructionist epistemology based on the work of Elgin and Goodman (1988) addresses all of the criteria above. Such an epistemological framework recognises that the purpose of enquiry is the advancement of understanding rather than the search for absolute truths. It views enquiry as seeking a deep understanding of the subject at hand. Pragmatic constructivism values propositional knowledge (pertaining to theoretical understanding i.e. 'knowing that') as well as procedural knowledge (relating to application i.e. 'knowing how to apply') and epistemic knowledge (the disciplinary conventions associated with a particular discipline). Furthermore, it recognises that prior learning matters in the way that it shapes how people make sense of their environments. It can be seen to build on the work of Dewey whose view of knowledge contradicted that of Aristotle because he did not believe there to be a stark divide between the theoretical and practical. Instead he viewed the theoretical as an offshoot of the practical and propositions being true only in so far as they were helpful or relevant in addressing problems (Pring, 1971). This view of knowledge provides a strong counter argument to critics of CfE who often protest that by focusing on the development of skills, knowledge is sacrificed (Paterson, 2009). A pragmatic constructivist approach views skills as a form of procedural knowledge.

DEFINING IDL

Key themes can be identified which coalesce around the notion of interdisciplinarity within Scottish policy documents including making links; providing relevant contexts; developing knowledge and skills; innovation and creativity; and partnership working. However, it is widely recognised that in relation to interdisciplinary matters there is a lack of conceptual clarity within policy (Harvie, 2018). For example, factors such as providing relevant contexts and developing knowledge and skills, can pertain as much to teaching and learning within discrete disciplines as they do to IDL, so these themes can often make it difficult to determine what is unique about interdisciplinary tasks. As a result of The Refreshed Narrative on Scotland's Curriculum, which was launched in September 2019, two documents entitled *Embedding Interdisciplinary Learning in Schools*, (The Royal Society of Edinburgh, 2020); and *Interdisciplinary Learning: ambitious learning for an increasingly complex world* (Education Scotland, 2020) have tried to provide further guidance. Both stress the importance of IDL within the curriculum while acknowledging that a lack of teacher understanding is one of the main barriers to embedding it in practice. These multi-authored documents provide subtly different definitions of IDL from each other and many of the references they provide are from previous policy documents, so their messages have a continuity with what has gone before. While the stated intention of each is to provide more clarity on the subject, it could be argued that many anomalies still exist, and important questions remain unanswered for practitioners such as those raised by Humes (2013) e.g. What should the starting point for teachers be when planning an interdisciplinary lesson?

More than fifty years ago, Pring (1971) recognised that the term 'integration' was not well defined or applied within education and it could be argued that the situation has not improved much since (Holbrook, 2013; Harvie, 2018:). Defining

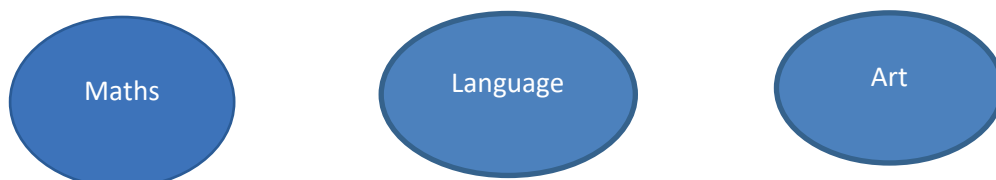
IDL is difficult for a number of reasons. There is a general lack of familiarity with interdisciplinary scholarship among educationalists (Klein, 1990). No synthesised body of discourse exists, and discussion instead is spread across professional, academic, governmental and industrial literatures (Klein, 1990: Holbrook, 2013). There is also a deficit of research around interdisciplinary approaches, which has led to difficulties in evaluating IDL work (Boix-Mansilla, 2017). The term 'interdisciplinary' itself, is an amorphous one, which can cause confusion. Part of the reason for this is that it is often used to describe very disparate and unrelated activities. For example, it can be applied to primary school children engaging in topic work; different departments within a secondary school working on a joint project; or university students from different disciplinary backgrounds taking part in research. These are only some of the many contexts which the umbrella term of interdisciplinarity covers.

To add to this complexity various prefixes to disciplinary are frequently used (e.g., trans-, multi-, cross- and supra-) giving rise to what Graff (2016), refers to as a 'storm of semantics' with regards to the blurring of disciplinary boundaries. There are also many frameworks relating to IDL with very little consensus reached about the phenomenon. Some of the organised models and descriptors around this area include: thematic/multi-disciplinary and interdisciplinary (Jacobs, 1989: Drake, 1991); fused, correlated and core (Vars, 1991); immersed and networked (Fogarty, 1991); curriculum integration (Beane, 1997); and cross-curricular (Barnes, 2007). Here it will be useful to differentiate between some common practices in schools.

Disciplinary learning

Disciplinary learning occurs when disciplines are taught discretely. It should be noted that school subjects are not the same as disciplines but that subjects are drawn from different disciplinary areas. Drawing on the Scottish context, within the primary school, subjects are largely drawn from discrete disciplinary areas for example, language, maths, science, art etc. These are often taught in isolation and in general the same teacher teaches the majority of subjects to one class. In secondary schools the teaching of subjects is generally done by different specialist teachers. This type of approach provides students with an essential knowledge base in the disciplines, but it can mean that students find it difficult to make links between the disciplinary areas (Fogarty, 1991). This difficulty was highlighted by the influential *Munn Report* (1977) which helped shape the structure of secondary schools in Scotland. It identified inherent problems of fragmentation and poor coverage of cross-curricular issues when teaching disciplines in isolation. Figure 1 below illustrates that when disciplines are taught discretely, they remain as separate entities.

FIGURE 1: DISCIPLINARY LEARNING



Cross-curricular Learning

When engaged in cross-curricular learning, the constituent subjects may relate to a particular topic, but are still experienced separately. Discrete subjects are taught but related to the context of a theme. In Scotland, primary schools have long used themes to teach the various subjects. *The Primary Memorandum* (1965), for example, directed that primary schools should have a more contextualised curriculum, linking the various curricular areas through topics. This led to many teachers using a ‘topic web’ approach to planning around themes such as ‘The Romans’, ‘People Who Help Us’ and ‘Climate Change’ (Harvie, 2018).

Topic webs are similar to mind maps, which have an idea or theme in the centre with separate areas of the curriculum plotted around and lessons relating to the central theme under each subject heading. For example, if a class is studying a science topic about ‘The Weather,’ the children, during language time may write a story about a stormy night. They will still be focussing on the skills of writing but the context for their story comes from the topic. During maths time they may count the number of rainy days and sunny days in the month and make a chart with this information. Again, they will be focussing on mathematical data handling skills during this exercise, but the context comes from the topic. Here, discrete subjects are studied separately but linked to the context of the central theme. Within the secondary sector this type of approach may involve the work of different departments coalescing round a particular idea, event or project. Again, students will be considering this topic during their discrete disciplinary classes and from the perspective of the different disciplines; so this would be cross-curricular.

FIGURE 2: CROSS-CURRICULAR LEARNING

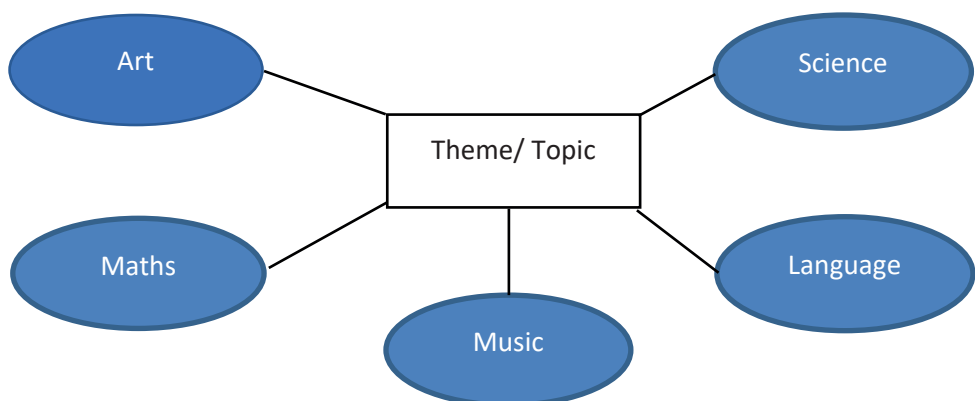
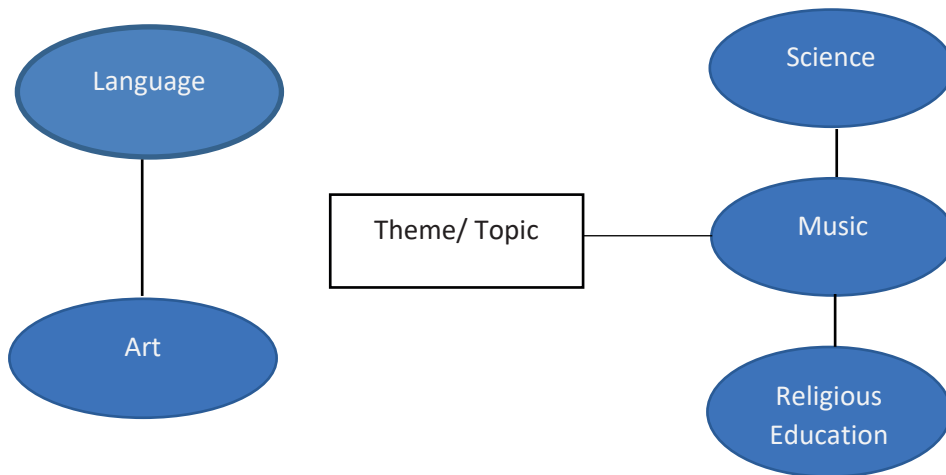


Figure 2 above illustrates how the disciplines are linked to the context of the theme or topic but taught discretely. Lenoir and colleagues (2000) use the term ‘pseudo-interdisciplinary’ to refer to this type of approach which they found to be common among primary teachers in Quebec when engaging in what they deemed to be ‘interdisciplinary practices’. As they point out, however, this is not genuinely interdisciplinary and can actually be detrimental and undermining to the social subject (e.g. history, geography etc), which constitutes the topic. This is because learning intentions come mainly from the other disciplines, resulting in the reduction of any meaningful level of learning about the social subject itself. What is important to recognise here is that cross-curricular activities or tasks, contain a singular disciplinary focus.

Multi-disciplinary Learning

Multi-disciplinary learning can be differentiated from cross-curricular because tasks do involve more than one discipline, however, the disciplines are juxtaposed and not integrated. Beane (1997) and Jacobs (1989) accept Meeth’s (1978) definition of a multi-disciplinary curriculum as that of involving the juxtaposition of several disciplines focused on one task but with no direct attempt to integrate (Dowden, 2007). Figure 3 below illustrates how a number of disciplines can be involved in a task and may or may not be related to a theme, but they are not integrated during the task.

FIGURE 3: MULTIDISCIPLINARY LEARNING



An example of this would be if students in a primary class were asked to create a poster involving mathematics and language by firstly constructing and uploading a mathematical table on to their computer and then using their language skills to populate their poster with the relevant information. Although this activity contains two disciplinary insights, students may compartmentalise the disciplines by undertaking each part of the task separately (e.g. they go to the computer suite to complete the maths section of the task and upload their tables and then return

to the classroom to begin to work on the language aspect). Disciplines are not integrated during the task. Within multi-disciplinary tasks, some of the essential elements which constitute IDL may be present but not all of them are. So, what makes an interdisciplinary approach different?

ACADEMIC DEFINITIONS OF IDL

Looking to academic definitions for clarity we find that when defining IDL, many commentators go further than merely suggesting a linking or crossing over of disciplines or disciplinary boundaries: they say that interdisciplinarity involves a fusion of knowledge to a level which would not be possible through working within disciplinary boundaries alone. Repko (2008) draws on a number of definitions of interdisciplinary studies and defines it in the following way:

Interdisciplinary studies is a process of answering a question, solving a problem or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline and draws on disciplinary perspectives and integrates their insights to produce a more comprehensive understanding or cognitive advancement. (Repko, 2008:12)

This definition of interdisciplinary education contains a theme which appears time and time again within the academic literature, namely that of students being involved in solving problems or finding solutions to questions which are pertinent to them. Indeed, philosophers such as Augustine (2009) have long seen problems as a source of knowledge creation. Brand and Triplett (2012) highlight problem solving as an important aspect in impelling students to find their own answers, draw their own conclusions, and create their own solutions. Virtue *et al.* (2019) argue that interdisciplinary lessons can be more efficacious when they are problem based but qualifies this by saying they must also be clearly and deliberately aligned to course material.

Some studies have shown that when students are given a purposeful challenge to design or create a product or artefact of some kind using more than one disciplinary insight, there have been positive results in terms of developing interdisciplinary competencies and disciplinary knowledge (Fortuin & Bush, 2010; Solomon & Salfi, 2011). This is often referred to as a project-based approach to IDL in the literature. However, when comparing project-based to problem-based learning, where a relevant problem is the driving force and problem-solving strategies are developed alongside disciplinary knowledge, Brassler and Dettmers (2017) found that problem-based approaches were much more effective. Their research findings conclude that a problem-based methodology enables students to establish their own interdisciplinary purpose, gain disciplinary insights and develop their ability to synthesize and reflect on learning. The issue schools are currently having to face, that of implementing socially distancing measures, may serve to illustrate this difference more clearly. Using a project-based approach a teacher might task pupils with designing a physical piece of equipment using their mathematical, design technology and linguistic skills to ensure social distancing in a given area is maintained. In a problem-based approach, however, the teacher

would pose the problem to students: 'How can we solve the problem of socially distancing in the lunch hall?'. This would necessitate the pupils thinking more deeply about the problem, hypothesising about possible solutions, debating and testing their ideas, formulating and designing their own solutions. The latter approach does more to foster the students' ability to reflect on their learning and synthesize knowledge.

Klaassen (2019) agrees that when designing interdisciplinary courses 'the problem' should be central to the learning outcomes. Such perspectives on curriculum development can be seen to have their roots in the foundational work of Dewey whose premise for knowledge creation was that throughout history, knowledge has been generated by addressing problems (Pring, 1971). Indeed, commentators such as Thorburn (2017:242) argue that Dewey's "learner led ideals" and problem-solving principles have much to offer in terms of providing guidance and traction for the implementation of IDL within the curriculum.

Statements about the need to make the curriculum more meaningful and more relevant to the pupils often accompany discourses around IDL. Establishing a purpose for interdisciplinary work is frequently cited as crucial in constructing effective activities and relevance to students is seen as vital (Beane, 1997: Boix-Mansilla, 2010: Hedge & McKenzie, 2016). Pring (1971) warns though that merely focusing on practical methods which may be motivating and engaging for pupils, does not necessarily lead to an integration of knowledge and can result in an instrumentalist view of education. However, it could be argued that if the problems and challenges posed are intellectually stimulating enough as well as being relevant, this is what acts as a catalyst for breaking down disciplinary barriers in the mind of the students and helps to unify their knowledge. Unification of knowledge is something in fact that Pring (1971) characterises as core in his 'strong thesis' for IDL.

Holbrook (2013) suggests that what theorists sometime ignore is the fact that certain disciplines (with their own internal logics, unique vocabularies, discourses and structures) may actually be incommensurate with one another. However, he asserts that 'communication' between disciplines is possible when there is a deep understanding of each disciplinary area. Boix-Mansilla (2004) agrees that IDL needs to be informed by strong disciplinary insights. Students must have the disciplinary knowledge they need to draw on before they can engage in an interdisciplinary task. Beldaro *et al.*, (2017) found that combining certain disciplines (art and science, in particular), enhanced the meaningfulness of tasks for students. This need for a strong foundational knowledge of the disciplines is the reason why Gardner (2006) argues that young children in the Early Years stages of education are not suitable candidates for IDL work because they do not have sufficient disciplinary knowledge to draw on.

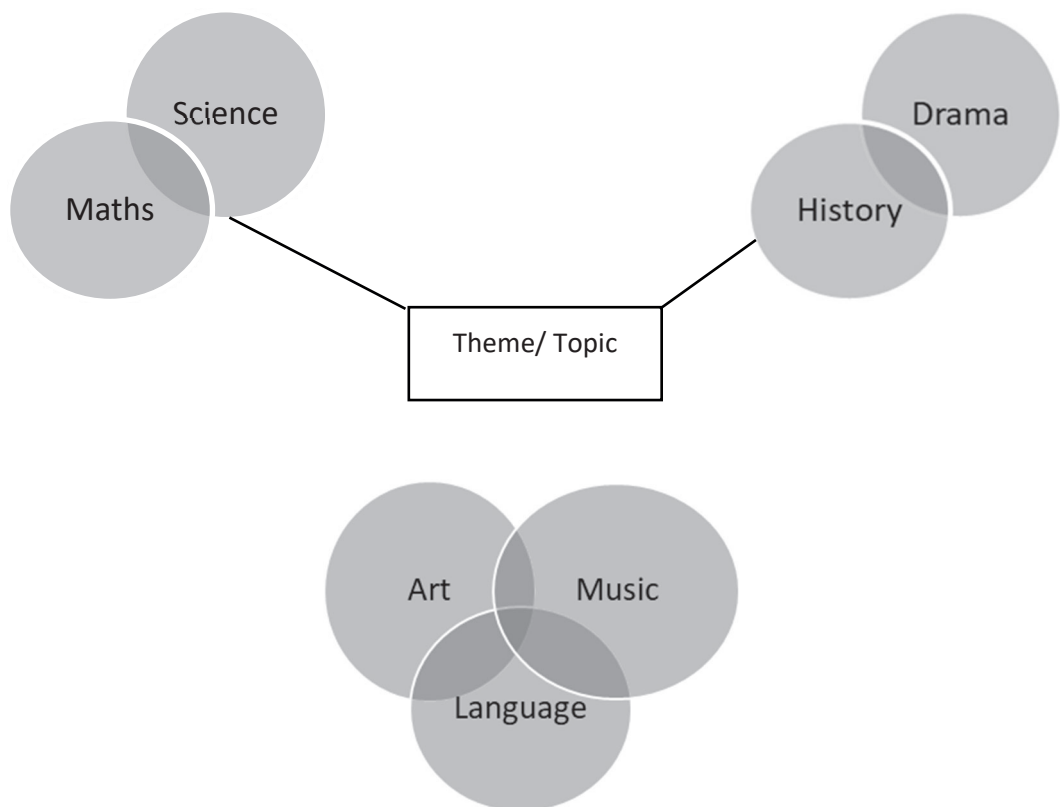
Another important aspect of IDL which is contained within Repko's definition is that of 'cognitive advancement.' Participants in effective forms of IDL are sufficiently challenged so that they further their knowledge and understanding beyond that which would be possible by studying compartmentalised disciplines individually. In doing so they are able then to transfer their skills and knowledge to familiar and unfamiliar contexts. As Humes (2013) observes, this idea of pupils being engaged in various types of problem solving, moves away from the traditional

notion of students simply acquiring academic information towards the student being able to apply their knowledge and skills to practical contexts. Hedge and MacKenzie (2016) observe that IDL involves more than just the acquisition of facts but can also lead to a development in the ability of students to reason in different ways, make judgements, assess and evaluate.

Interdisciplinary Learning

The interdisciplinary approach then is one which propels students to draw on their existing disciplinary knowledge and skills (from two or more disciplines), in order to complete a sufficiently challenging activity or problem which they have been set or have set for themselves. So, while cross-curricular and multi-disciplinary tasks may blur disciplinary boundaries, IDL goes further and fosters synthesis, resulting in cognitive advancement in the respective disciplines (Repko, 2008). As can be seen from Figure 4 below, during interdisciplinary activities, the disciplines are integrated during the process of undertaking the tasks which may or may not be related to a central theme as this figure shows.

FIGURE 4: INTERDISCIPLINARY LEARNING



CONCEPTUAL FRAMEWORK

To summarise from the above then, the key elements which emerge from the academic definitions of IDL are that:

1. The starting point is a problem or challenge which is too broad to be dealt with by one discipline alone and challenging enough to promote cognitive advancement.
2. The IDL activity should be purposeful, meaningful and relevant to the students.
3. There should be a grounding in two or more disciplines in order to draw upon them to address the interdisciplinary task.
4. During the interdisciplinary process knowledge from the different disciplines is applied and integrated in the mind of the learners.

These elements align with what Boix-Manislla (2004) terms as the core premises of IDL. The diagram below offers a framework to illustrate the nature of the relationship between the elements outlined above and the experiences students gain in the process.

FIGURE 5: RELATIONSHIP BETWEEN CORE ELEMENTS OF IDL

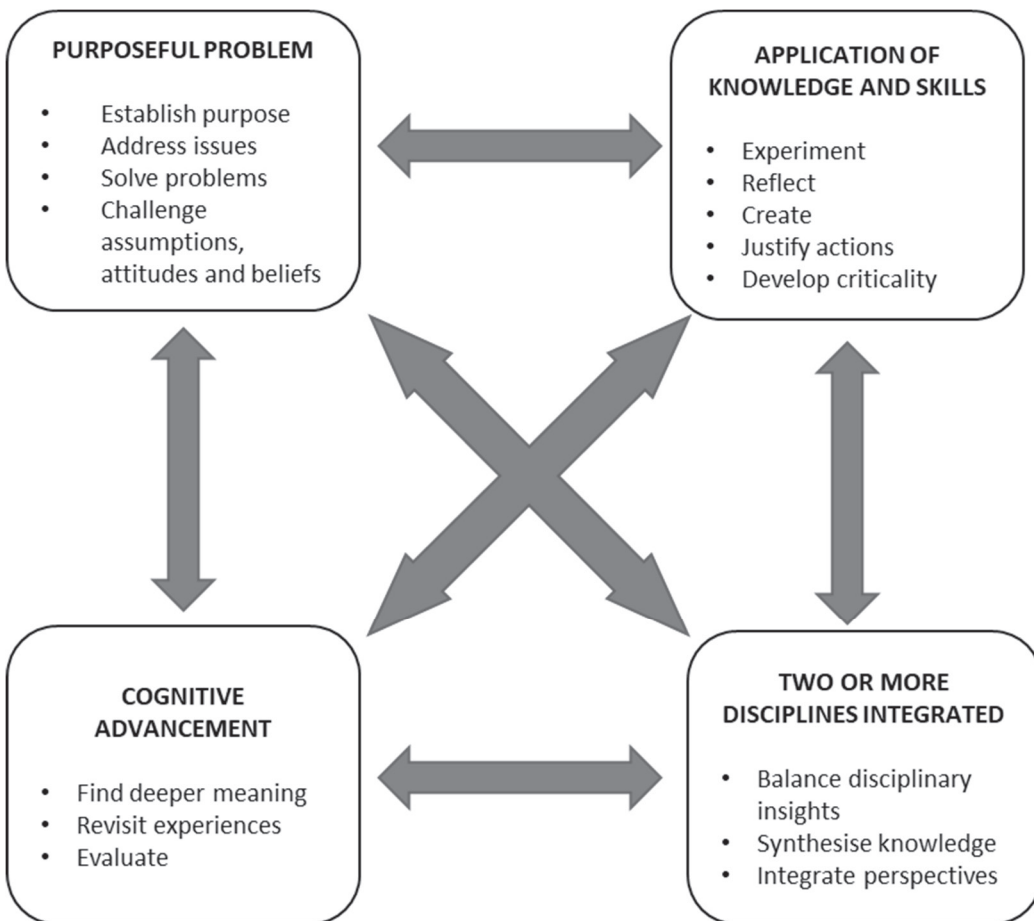


Figure 5 demonstrates that an interdisciplinary approach begins with a problem, question or issue which is meaningful to the learner. This has to be sufficiently challenging and purposeful to impel the student to apply and integrate their knowledge and skills from two or more disciplinary areas in order to solve or answer it. During the activity pupils engage in a process of reflective equilibrium, defined by Virvidakis (2015:77) as “...a state of coherence of our thoughts about one or more issues, resulting from a deliberative process of mutual adjustment of beliefs, principles, theories, and arguments.” This involves students developing criticality, reflecting, justifying their actions, integrating perspectives, revisiting their experiences and evaluating their findings throughout the process as illustrated by the diagram. The arrows indicate that this is not a linear process but is more rhizomatic in nature. So how can IDL be realised in the classroom?

PEDAGOGICAL APPROACHES

There are a variety of different pedagogical models of integrated or interdisciplinary practices that theorists over the years have presented. What these approaches have in common is that they can generally be categorised into two main areas, namely: those which are content-centred, where subject matter is foremost; and those which are student-centred, where pupils are central to curriculum making and democratic practices are advocated. It has been argued that confusion stems from a lack of pedagogical understanding concerning the historical theories that underpin the various integrated models (Beane, 1997). Dowden (2007), suggests, that to utilise a framework using just these two models is effective in simplifying the analysis of the discussion without having to sacrifice accuracy. These two approaches, therefore, will now be considered.

Content-Centred

Content-centred approaches are related to what has to be covered in the curriculum and these have their roots in the late 19th Century work of German philosopher Johan Friedrich Herbart and a group of educational reformers known as Herbartians, who were interested in his work (Dowden, 2007). These questioned the teaching of discrete disciplines (or subjects drawn from the disciplines) and began to look for ways of correlating them together to make connections which would be of benefit to students. This was based on the belief that a key to intellectual growth was a pupil’s ability to make connections across disciplinary domains. The concept of connecting or correlating disciplines, was then developed and correlation is a term which is still used today. Content-centred approaches begin the curriculum design process and the subject matter which has to be covered. Fogarty (1991) provides a useful paradigm to consider. There are ten detailed components ranging from fragmented disciplinary teaching to a networking phase (interdisciplinary learning). This model suggests that changes in what the teacher does in the classroom can lead to pupils making connections at all stages and taking ownership of their own learning in whatever disciplinary area is being taught. It is, therefore, highly teacher dependent, although at the ultimate stage Fogarty proposes that the learners themselves will direct the focus of their learning and target necessary resources as they expand their knowledge

and network. Setting challenges or a problem to be solved is not a major feature of this model, although the implication is that pupils themselves will generate their own problems and challenges at the networking phase.

Another example of this type of content driven approach comes from Jacobs (2004) who advocates a type of curriculum mapping involving teachers planning collaboratively for long term periods, so as to maximise learning within disciplines and topics being planned. One advantage of this type of long-term overview is that there is a structure for teachers to follow, ensuring a progressive coverage of disciplinary areas and topics without overlaps for the pupils as they progress. Jacobs (2004) recognises that merging concepts from various disciplines can enhance the learning experience of students, but this is very much centred on the subject matter to be studied and not the interests of the student. Virtue *et al.*, (2019) warn that unless teachers carefully match interdisciplinary tasks with course content then students may not experience deep learning. However, there are those who claim that such content-centred practices are heavily top-down, where the teacher has the power and control, and pupil voice is diminished as a result (Dowden, 2007). Critics of these approaches argue that they are based on 'thin' ethical principles (Apple, 2001), because they fail to pay sufficient attention to learners needs and their sometimes widely differing abilities and contributions (Vars, 2000).

Student-Centred

By way of contrast, student-centred pedagogies have their foundations in the work done by Dewey from the end of the 19th Century up until the 1930s, when forms of 'organic education' began to emerge. Dewey's curriculum design recognised the relationship between student learning and social environment and experience, placing the student and their community at the heart of the curriculum rather than subject matter. Social constructivist theorists such as Vygotsky (1978) have developed the notion that learners construct knowledge during social interactions, changing and developing what they already know. This interaction can happen spontaneously by learners or be initiated, managed and directed by teachers. Student-centred approaches are based on such theories of learning. The Stenhouse Humanities Curriculum Project (Stenhouse, 1968) provides an example of this from the United Kingdom where a pedagogy of enquiry was promoted and interactions between teachers and students were developed. Beane's (1997) integrated curriculum model provides another example from the United States with a focus on the problems and interests most relevant to the young person. This model starts with pupils' curiosities and concerns, which generate questions and problems to be answered and solved. Central to Beane's work is a view that the experiences of students should be meaningful and memorable, knowledge should be created through a democratic, co-constructed curriculum, exploring social and personal issues, knowledge should be applied without disciplinary boundaries, and that curriculum design should embrace democracy, diversity and dignity. Beane's model is very prevalent today in the middle schools of America and has set a precedent for how educators within these schools think about the curriculum (Brinegar *et al.*, 2020).

Bernstein (1971) claims that student-centred approaches result in an integrative curriculum, where subject matter holds less importance than the organising theme and where disciplinary knowledge is called forth only if relevant to the topic being studied. This type of pedagogy could be considered more ethically 'thick' (Apple, 2001) than content-centred ones, because it takes account of the interests and differences in pupils' needs, but critics argue that this can be 'woolly' and result in a patchy and interrupted coverage of the 'official knowledge' and values of the dominant political group (Apple, 1993). Murdoch and Wilson (2004) highlight the tension which exists for teachers in trying to meet the requirements of the curriculum while responding to the needs and interests of their pupils. They recommend that, in the ideal situation, a unit of work should be planned after the student's prior knowledge has been considered, and that the unit of work, while being prescriptive enough to cover the curriculum requirements, should have enough flexibility to adjust to the needs of students. They acknowledge, however, that this is not always practical.

IN PRACTICE

In real terms, it may be that schools adopt a mixture of both the content-centred and student-centred approaches when planning IDL. Naylor (2014), for example, states that the dichotomy between the two should in fact be played down because these positions are not in opposition but sit side by side. Naylor holds that in a practical context, where teachers are planning, teaching, assessing and reporting on a range of curricular areas, they are in the best position to purposefully make curricular connections and to map out programmes of work, to ensure students have a progression, breadth and balance of learning experiences. Implementing a problem-based interdisciplinary approach means that teacher judgement is key. What is also important is that practitioners need to be able to adopt facilitative roles, to manage student work without overly directing it, and to support students' efforts to become self-directed learners (Ertmer and Simons, 2006). One of the biggest challenges that teachers face as they begin using these methods is that of assuming a less directive role (Ward and Lee, 2002). In general, the teacher in a problem-based IDL approach acts as a guide who helps students collaborate to generate solutions to problems (Kolodner *et al.*, 2003). The emphasis shifts from a focus on grades, competition, and public comparison with others to that of enquiry and understanding (Gallagher, 1997). The teacher becomes a facilitator of learning rather than simply a transmitter of knowledge.

Klein (1990), argues that there is no one pedagogical approach that best fits interdisciplinary work but that what is essential is good general learning and teaching. Although this seems rather vague, she does go on to list some key factors which she claims should be involved in the process, one of which being teachers' discussions related to an interdisciplinary theme or question or problem. This idea of discussion and professional dialogue is echoed by many other commentators on the subject. So, what do schools need to do if they wish to address the IDL implementation gap? Some factors which may help to facilitate effective IDL will now be considered.

FACILITATING FACTORS FOR IDL

Fostering collaborative cultures and developing sense making

Many commentators extol the benefits of collegiality arguing that fostering professional dialogue in schools where teachers have time to talk about their practice, is key to promoting any kind of curriculum development (Boreham and Morgan, 2004; Hargreaves and O'Connor, 2017). It could be argued that because of the complex nature of IDL, collaboration among teachers around this area is especially important and necessary (Klein, 2009). In developing an interdisciplinary pedagogy, teachers not only have to be able to differentiate IDL from other approaches (i.e. cross-curricular and multi-disciplinary) but they also have to design (often bespoke) tasks for their pupils. Lenoir and colleagues (2000) found that when teachers had a poor understanding and education in the area of interdisciplinarity, it resulted in what they called an 'eclectic approach' to IDL being adopted. This describes a 'pick and mix' attitude to teaching IDL, with no clear perception of how well certain disciplines fit together and how best links can be made. Here, elements from a variety of subject areas are chosen and taught, but with no clear rationale, structure or relevance to their selection. Shoham (1998) examined teachers' understandings of interdisciplinarity and found that, in order to effectively implement interdisciplinary work, there needed to be more professional dialogue to help teachers make sense of interdisciplinary matters, with development and training provided during initial teacher education, and inset days. As Shulman suggests, "The teacher is not only a master of procedure but also of content and rationale, and capable of explaining why something is done" (Shulman, 2013:10).

Opportunities for teachers to engage in continuing professional development where they have the chance to reflect and discuss their understanding of IDL is therefore crucial in enabling them to craft IDL tasks and speak confidently about what they are doing and why. Hargreaves (1994) adopts a micro political perspective to analyse collegiality, however, considering the idea that collegiality and collaboration can be imposed on teachers as an exercise in organisational power, this could be seen as 'contrived collegiality.' This should be distinguished from collaborative cultures where teachers discuss issues around practice that they generate and direct themselves, making sense of things that are relevant to them.

Time

Nariman and Chrispeels (2016) acknowledge that time is a major factor in planning effective IDL projects and practices because teachers must take account of a range of factors including the prior knowledge of pupils. Garcia (1990) found that teachers involved in an IDL project at Pajaro Middle School in California, said that they would not have been able to carry out the IDL work without being given the time to meet and plan activities. Teachers first have to think of appropriate challenges, problems and questions which will enable young people to apply their knowledge and skills from more than one disciplinary area in order to develop their cognitive thinking. It is very probable that traditional textbooks and curriculum guides will not have all the answers. Teachers, who begin to plan for this integrative, interdisciplinary work, may find that there are limited resources to

support them and they have to find or create the materials themselves. This process may be difficult for teachers who feel they do not have free time to spare, especially when materials are readily available to support traditional lessons that cover the same content (Ward and Lee, 2002).

Institutional Support

Support by management is also a critical factor in the implementation of IDL (Harvie, 2018). This is needed for aspects such as funding the cost of resources, facilitating cover for teachers to be trained, devoting time on the collegiate calendar for planning and staff development (Brassler and Dettmers, 2017). Hord and colleagues (1987), suggest that the first step to facilitating change within a school is to provide funding and other unique resources such as recruitment of parent volunteers or local industry for example. Baumfield and colleagues (2009), observe that failure to provide an investment in resources to enable teachers to engage in meaningful curriculum development, is to lessen the chances of teachers changing their practices and fulfilling policy intentions.

EXAMPLES OF IDL PRACTICES

An example from the literature which fits with this problem-based IDL model can be seen in the research carried out by Min and colleagues (2012) in secondary schools where pupils considered an Integrated Life Skills study. During this study, teachers helped students to identify real life problems or needs to be resolved. The problems were contextualised within a relevant theme and related to issues facing students in their daily lives. Solutions were formulated by students themselves and various types of technology used to design an artefact of some kind which could address the problem posed. Students worked independently of the teacher to gather information and data through observation, visits, brainstorming, reading and researching on the internet and used their knowledge and skills from design technology and other disciplinary areas in designing and creating a solution. Teachers involved in this research were found to have a high level of understanding of the features of an integrated thematic approach.

Brinegar *et al.* (2020) and Hinde (2005) provide further examples and use studies set in both primary and secondary schools to demonstrate benefits from 'integrated or interdisciplinary' methods involving issues relevant to the pupils who adopt a problem-solving, integrative approach. These studies report increased engagement, more positive attitudes, and improved effort of students due to the use of relevant contexts. This type of IDL is in line with the conceptual framework presented in this article where students draw on their existing knowledge from two or more disciplines to address an issue or problem which is relevant to them.

PLANNING IDL

It may be helpful to consider the following steps when planning and constructing an IDL task, but it should be noted that the order given below is only a suggestion for practice and not meant to be prescriptive. In line with the pragmatic constructivist epistemology adopted in this article, it is recognised that, although there are key components of IDL (outlined in Figure 5), interdisciplinary

activities are varied and diverse so flexibility and adaptability are necessary both in the planning and implementation stages. It may be, for example, that an immediate problem presents itself and so becomes the starting point for the planning process.

Step one - Consider the source – Will a student-centred or content-centred approach be taken?

In planning an IDL activity a problem or challenge needs to be identified so the teacher will have to decide first of all if this will come from the interests of the pupils (student centred) or from the topic, theme or subjects being covered (content-centred). If taking a student-centred approach there may be a topical or local issue that pupils are interested in or worried about e.g. global pandemics, global warming, air pollution, the need for foodbanks etc. This could be used as a starting point for engaging students in an IDL problem solving challenge. Alternatively, there may be an issue or a problem which arises out of the context of the topic or subjects being studied. The problem or challenge might be related to a historical event that is being examined (e.g. The sinking of the Titanic or World War II). Here the teacher would have to ensure that the problem was purposeful and meaningful enough to the pupils to engage them.

Step Two - Identify the problem / issue / challenge

This is the catalyst which drives pupils to integrate their disciplinary insights in seeking a solution or answer to the problem, question or challenge posed. It must be relevant and purposeful to the pupils. The question posed to the students also must be sufficiently challenging so that they will advance cognitively in the disciplines involved.

Step Three - Ascertain the disciplines students will have to use to address this problem / issue

Practitioners should think carefully about which disciplines students will be required to use to address their IDL challenge and if pupils have sufficient knowledge in these disciplinary areas. Beldaro *et al.* (2017) found the arts and science were a particularly good combination in terms of bringing relevance and meaning to the pupils' learning experience. Students need to have a grounding in the disciplines they require to use before being asked to apply their knowledge and skills. This means, for example, in a challenge which involves using drama and science, the IDL activity would need to be preceded by discrete disciplinary lessons in these areas to provide the students with the foundational knowledge and skills required. Virtue *et al.* (2019) suggest that it is important for the disciplines involved to be balanced in terms of their weighting in the task so that students feel they have gained something worthwhile from the process.

Step Four - Design the task

Pupils should be able to see the relevance of the task and find it meaningful. As mentioned above, teachers may find it beneficial to collaborate with one another to generate ideas for tasks which may be suitable. The teacher sets the challenge and then adopts a facilitative approach encouraging pupils to self-direct but offering support and guidance when necessary. Interdisciplinary studies are based on constructivist approaches to learning where knowledge is co-constructed by the pupils (Corney and Reid, 2007). Groupwork therefore may be advantageous here allowing pupils to discuss their ideas and work out solutions. Harvie (2012) suggests that structured methods for group work such as Cooperative Learning (Craig and Ward, 1999 and 2006), goes hand in hand with IDL, especially for younger pupils as it is aimed at providing them with the skills needed to work productively in groups and independently from the teacher.

Step Five - Assess the learning

For teachers to develop more confidence in implementing IDL work, assessment is an area which has to be addressed (Boix-Mansilla, 2004). IDL tasks may take any number of forms including the production of a written piece of work, the creation of a video, a presentation, or a piece of art or artefact. Some possible questions for assessment could include:

- Has the student been able to apply their knowledge from two or more disciplines to complete this task?
- Have the disciplines been integrated in the process (not merely juxtaposed)?
- Is there evidence that the student's knowledge and understanding of the disciplines involved has increased?
- Is there a clear purpose, sense of reflection and self-critique in the work?

The first of the questions above relates to the disciplinary insights which need to be used to complete a task. The task or challenge would have to be carefully constructed by the teacher to help students engage with more than one discipline. Depending on the pedagogical approach of the teacher, pupils could have a greater or lesser degree of influence on which disciplines they used and how they used them. For example, a teacher might predetermine which disciplines they wished to target and choose a task which would necessitate those particular areas to be used (e.g. targeting technology and maths by asking pupils to design and build a structure from technological equipment supplied) which would allow villagers in Africa to carry water from wells to their houses. This is more aligned to a project-based approach to IDL as described above.

Alternatively, using a learner-centred problem-based approach, the students could determine which way they accomplished their work. For example, when explaining the problem of carrying water for villagers in Africa, and asking pupils to come up with ideas of how to solve this problem and present these ideas in a way of their own choosing, they could decide to draw pictures and diagrams, make videos and do presentations about their ideas, write a song or poem or create an artefact as a response. The teacher would then have to find ways to assess

whether cognitive advancement had been made. This could be done by a variety of means including listening to pupils reporting back; questioning; observing students during the process; and inspecting the final products of the work. The fourth area for consideration is whether students had been purposeful and self-reflective.

By considering IDL in terms of the source, the problem, the disciplines, task design and assessment, teachers can begin to structure and plan problem-based interdisciplinary activities in the classroom.

CONCLUSION

To conclude, this article has argued that IDL has often been poorly articulated, rarely exemplified and often misunderstood by teachers resulting in an implementation gap at school level (Shelley, 2019, Royal Society of Edinburgh, 2020). To address this disparity between policy and practice a pragmatic constructivist epistemology for considering interdisciplinarity has been presented. Key elements of IDL from the literature have been identified in attempting to differentiate IDL from cross-curricular and multi-disciplinary practices and a conceptual model for educators to consider has been offered. It has been recommended that in planning IDL teachers consider whether a content-centred or student-centred approach is most appropriate for their context and that the starting point for activities should involve a challenging problem, question or issue to address. Factors which promote IDL in schools have also been considered and these include fostering collaborative cultures; providing institutional support; and setting aside time dedicated to developing IDL. Finally, some suggestions have been made as to how practitioners might begin the planning process when designing interdisciplinary lessons and tasks. It is hoped that this article will go some way to further discussion on interdisciplinary matters so that IDL can become more than just a chimera in the Scottish education system and beyond.

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