

REPORT 1 ANNEX

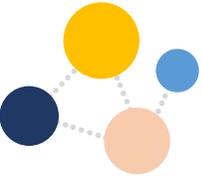
Conceptualising Curriculum Integration:

*A Synthesis of Theory,
Research and Practice*

*Tabulation of Studies from
the Systematic Review*

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This annex accompanies the following report:

Conceptualising Curriculum Integration:
A Synthesis of Theory, Research and Practice

Report 1

Examining Integration, Pedagogy and Assessment in the
Context of the Redeveloped Irish Primary School Curriculum

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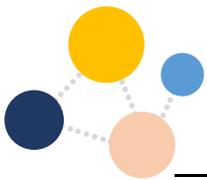
January 2023

This annex can be cited as:

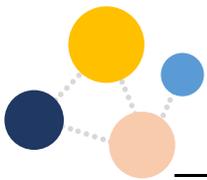
Burke, P. & Lehane, P. (2023). *Conceptualising Curriculum Integration: A Synthesis of Theory, Research and Practice - Annex 1*. Dublin: National Council for Curriculum and Assessment.



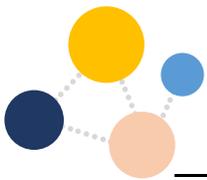
Lead Author (Year), Location	Description	Study Design (Tools)	Sample (N)	Use of Integration	Outcomes	Study Limitations	Publication Type
Aguirre-Munoz (2021) United States	To develop their professional knowledge on curricular integration, teachers were: (i) presented with foundational articles describing several conceptions of integration (ii) engaged in online discussions; and (iii) completed collaboratively designed integration lessons with math and science. Observations of integrated lessons were conducted at the start and end of a term's instruction.	Mixed Methods (Pre-Post Scores [Modified Math and Science Integration Rubric], Reflection Journals)	In-Service Teachers (N=23)	No single integration model was emphasised in the training course. However, the assigned readings appeared to support teachers' understanding of curricular integration by encouraging the identification of 'synergistic relationships' between subjects (e.g., key content, skills, practices).	Teachers demonstrated growth in their ability to integrate math and science content as demonstrated in the statistically significant improvement in MASIR scores ($r=.80$). Teachers perceptions and knowledge of CI positively shifted over the course of the intervention.	(i) Intervention was not fully completed when post-test data was gathered, (ii) No learner outcome data	Journal Article (Peer Reviewed)
Akbar (2012) United States	The teacher in this study integrated ELA concepts into mathematics; vocabulary instruction, use of comprehension strategies, writing about mathematical concepts. Student understanding was tested before and after using the chapter test from the classroom textbook; further data was also gathered through questionnaire/Likert items and analysis of student work and teacher lesson plans. The authors claim that students benefitted attitudinally and academically from having ELA concepts integrated into mathematics; there is a lack of clarity around the control group which undermines the conclusions of the study.	Pre-post with no control; measures included the Georgia GPS Edition of the Mathematics Coach book (chapter tests); surveys (using Likert items), lesson plans, student work samples	Fifth Graders (N=64), one school/class	The author invokes the term 'interdisciplinary' or integrated to describe how English/literacy concepts and approaches are integrated with mathematics teaching. No one model for doing this is endorsed (though Biddle [2007] is cited); rather, examples of the synergies between both are outlined, e.g., explicit instruction on vocabulary; construction of explanations; writing descriptions of mathematical concepts; oral explanation of problems; use of reading material/stories and comprehension strategies in maths; integrating genres like recipes.	The study reports that student scores in maths increased from pre to post-test; it is difficult to attribute this solely to the integration of language arts concepts as the control group is poorly explained/conceptualised in the study. Students reported positive attitudes towards this form of mathematics teaching/integration.	(i) There is a lack of clarity in the reporting of the intervention/control groups' scores, meaning it is difficult to be confident in the interpretation of these data.	Doctoral Thesis



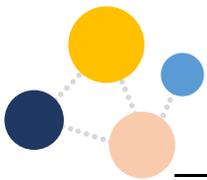
<p>Alghamdi (2017) Saudi Arabia</p>	<p>This study examined the effects of an integrated mathematics and science curriculum on academic achievement in a private Saudi Arabian elementary school. An integrated unit was developed from a 5th grade 'Sound and Light' science unit and a 5th grade 'Perimeter, Area and Size' mathematics unit. The control group (2 classes: Class 1, Class 2; n=86) addressed each subject's unit separately while the treatment group (2 classes: Class 3, Class 4; n=76) experienced an integrated approach to instruction that used practical activities that were said to be relevant to the students' everyday lives. All courses were taught by the same two teachers: Teacher A (Math teacher) and Teacher B (Science teacher). Teachers A and B collaborated to teach the integrated unit in Classrooms 1 and 2 (experimental condition). Teacher A also taught her regular math class (Class 3) and Teacher B taught her regular science class (Classroom 4). Data was gathered at the start and end of the 8-week intervention.</p>	<p>Experimental Pre-Post Test with control group (Researcher Designed Materials); Treatment: n=76, Control: n=86</p>	<p>5th grade learners (N=162)</p>	<p>The authors initially discuss curricular integration in general terms. They then identify the multiple connections between science and mathematics content that can support the integration of these subjects. The authors argue that the success of an integrated science and mathematics unit 'hinges on relevance to real-life applications' (p. 6083). The authors use this idea to construct six standards that should guide the process of integrating science and mathematics teaching using real life applications: Balance, Adaptation, Learner-centred, Flexibility, Continuity, Functionality. From there, the authors propose the POWER strategy, This acronym captures the 5 stages involved in planning integrated science and mathematics units: planning, organisation, work-life activities, evaluation, and real activities.</p>	<p>There was a significant difference ($p < 0.01$) between the post-test science and maths scores of the treatment and comparison groups. While all groups had improved test scores, the treatment group outperformed the comparison group on both tests.</p>	<p>(i) Suitability of the outcome measures involved should be queried in terms of its suitability i.e. was a vocabulary test the best way to measure learning? (ii) Further details on the actually integrated science/maths unit was required to fully understand the differences between the experimental conditions, (iii) Inadequate reporting of statistical analyses and measures (iv) No mention of observation data gathered</p>	<p>Journal Article (Peer Reviewed)</p>
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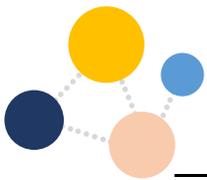
<p>An (2014) United States</p>	<p>An experimental approach (using a pretest-posttest control group design) was used in this study to examine the impact of music-mathematics integrated lessons on 3rd grade students' mathematics achievement and dispositions, including beliefs about success, attitude, confidence, motivation, and usefulness. The students in the music group received music-mathematics integrated lessons, while the students in the control group received a more traditional approach to mathematics instruction.</p>	<p>Experimental Pre-Post Test with control group (Mathematics Disposition Survey [adapted from the Fennema-Sherman Mathematics Attitudes Scales]); Treatment: n=28, Control: n=28</p>	<p>3rd grade learners (N=56; 2 classes)</p>	<p>No particular model of integration was advocated in this study. Instead, the specific value of learning mathematics in a music-based disciplinary curriculum was discussed.</p>	<p>Analysis of the post-test scores indicated that the treatment group ('music') had statistically significantly higher scores in mathematical dispositions than the control group ('non-music') students after the intervention ($p < 0.001$; $d = 1.37$). Post-hoc tests revealed that the treatment group demonstrated a statistically significant higher disposition score in the post-test than pre-test in all six mathematics disposition areas measured with large to very large effect sizes noted; mathematics confidence [$d = 0.94$], attitude [$d = 1.46$], usefulness [$d = 1.88$], success [$d = 1.18$], motivation [$d = 0.74$], and beliefs [$d = 1.98$].</p>	<p>(i) Research did not seem to address the unequal role assigned to the two subjects i.e. maths learning was prioritised over music learning, (ii) music based outcome measures were required to support some of the assertions made in the discussion section, (iii) possible Hawthorne effect (novelty of intervention in experimental group), (iv) Minimal discussion of how potential confounders were controlled for</p>	<p>Journal Article (Peer Reviewed)</p>
<p>An (2013) United States</p>	<p>This study investigated how two elementary school teachers designed music-mathematics interdisciplinary lessons. The two participant teachers attempted to design and implement music activities as an integrated part of their regular mathematics lessons over a five-week period with their 1st (n=21) and 3rd grade (n=25) learners.</p>	<p>Quasi-Experimental Design with Pre-Post Test data (Observations of lessons; Researcher Designed rubric)</p>	<p>1st (n=21) and 3rd Grade learners (n=25) (N=46); In-Service Teachers (N=2)</p>	<p>The authors discuss how an interdisciplinary mathematics-music integrated instruction has the potential of improving students' attitudes toward learning mathematics and of increasing students' mathematics achievement. The authors discuss An's (2012) proposed five-phase instructional model for music-mathematics integrated lessons. Each phase contains varying levels of focus on music and mathematics.</p>	<p>The ability levels of the first and third grade students in all three mathematical areas as assessed by the researcher designed rubric (which aligned with that state's core standards) showed statistically significant improvements. Large effect sizes were found in both first grade and third grade students before and after three MSA areas with Cohen's $d > 1.66$</p>	<p>(i) Bias within sample (teacher qualifications/interest), (ii) Researcher designed instruments, (iii) short intervention period (Hawthorne effect), (iv) Minimal discussion of how potential confounders were controlled for</p>	<p>Journal Article (Peer Reviewed)</p>



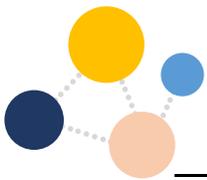
<p>An (2017) United States</p>	<p>This study examined how preservice teachers' self-reported approach to mathematics–science integrated teaching was affected by participation in an 8-week programme of 'exemplary' interdisciplinary activities as part of their instruction in programme of initial teacher education.</p>	<p>Pre-Post Intervention Study with no control (surveys)</p>	<p>Pre-Service Teachers (N=28)</p>	<p>The authors created the 'Interdisciplinary Pedagogical Content Knowledge' model to demonstrate how pedagogical knowledge (PK), content knowledge in subject A (CK-A), and content knowledge in subject B (CKB) is required for the successful design and implementation of interdisciplinary teaching. The authors noted that this model describes the capacity of teachers to accomplish the following: (1) work with interdisciplinary considerations that include an understanding of the representation of concepts using themes across curriculum boundaries, (2) apply pedagogical methods and interdisciplinary themed activities in addressing content areas from multiple subjects simultaneously, (3) identify knowledge connections within and between particular subjects, and develop lessons based on such connections; and (4) employ knowledge of how interdisciplinary explorations can be developed as a part of an instructional process wherein students link existing knowledge across curricula, while presenting that new knowledge through contexts from multiple subjects (p. 239).</p>	<p>According to the authors, analysis of the qualitative data gathered revealed that the pre-service teachers' interdisciplinary knowledge of using science-themed activities as instructional approaches for teaching mathematics had significant changes across all three science content areas examined (i.e. physics, chemistry, and biology). Participants were able to generate more interdisciplinary teaching strategies for their proposed lesson plans after their 8-week intervention. Furthermore, the authors considered the teaching strategies included in these plans to have 'more profound interdisciplinary connections' (p. 246).</p>	<p>(i) sample (size and homogeneity), (ii) insufficient description of potential confounders, (iii) in adequate discussion of logistics involved in implemented the lesson plans constructed by the per-service teachers</p>	<p>Journal Article (Peer Reviewed)</p>
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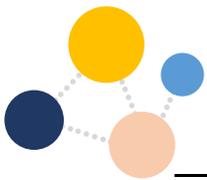
An, Tillman (2014) United States	<p>This study examined pre-service teachers' perceptions of music-mathematics integrated curriculum and instruction. The participants experienced six 40-minute interactive music-mathematics integrated activities during the course of their regular studies.</p>	<p>Intervention (no pre-test data gathered; post-intervention data included a reflective essay and discussions with peers in an online forum)</p>	<p>Pre-Service Teachers (N=53)</p>	<p>No particular model of integration was advocated in this study. Instead, the specific value of learning mathematics in a music-based disciplinary curriculum was discussed. The authors used the term 'interdisciplinary' throughout the paper without offering an explicit definition.</p>	<p>Pre-service teachers' perceptions about music-mathematics integrated curriculum and instruction were categorised under four key themes: (1) Fixing common mathematics education problems (e.g. anxiety, appropriate challenge), (2) Improving student academic achievement, (3) Engaging mathematics education with enjoyable experiences, (4) Developing creativity in Math teaching and learning. After engaging with the intervention, pre-service teachers were able to identify multiple ways of integrating music activities into mathematical content across a range of areas (e.g. numbers & operations, algebra, geometry etc.).</p>	<p>(i) researcher bias/power imbalance, (ii) sample size was small and relatively homogenous, (iii) lack of pre-intervention data, (iv) self-report data</p>	<p>Journal Article (Peer Reviewed)</p>
An, Tillman (2014) United States	<p>This study explored the strategies pre-service and in-service teachers used to integrate mathematics education into music-themed activities. The study also examined the differences between the preservice and the in-service teachers' strategies. A total of 78 lessons plans were collected from the participants to address these research questions (Pre-Service Teachers: 37 lesson plans, In-Service Teachers: 41 lesson plans).</p>	<p>Pre-Service and In-service Teachers (N=45)</p>	<p>The study provides a general description of arts-integrated curricula e.g. 'an integrative arts-based interdisciplinary curriculum emphasizes enabling students to transfer their developing understanding and knowledge between the arts and subjects not traditionally associated with the arts' (p. 22).</p>	<p>Using a grounded theory approach to analyse the lesson plans developed by the pre- and in-service teachers, music themed activities were generally based on four musical content areas: (1) listening and singing, (2) composing and performing, (3) musical notating, and (4) musical instrument designing. These different music-themed activities were used to support mathematics teaching from five general content areas: (1) numbers and operations, (2) geometry, (3) algebra, (4) data analysis and probability, and (5) measurement. In-service teachers and pre-service teachers demonstrated different patterns regarding their use of music-themed activities and their mathematics content foci e.g., 27% of pre-service teachers' lesson plans were based on music listening and singing activities while only 10% of in-service teachers used this type of music activity.</p>	<p>(i) Poor description of sample characteristics/experiences e.g. breakdown of sample into pre- and in-service teachers</p>	<p>Journal Article (Peer Reviewed)</p>	



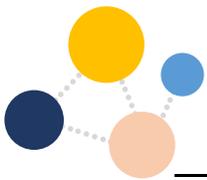
<p>Anderson (2015) United States</p>	<p>This study investigated the effect of integrating drama into ELA lessons on teacher speech patterns and the on-task behaviour of students with learning disabilities and ADHD.</p>	<p>Observational (teacher speech acts; student on-task behaviour)</p>	<p>Third grade students with learning disabilities and ADHD (N=26); in two classrooms (N=2 teachers)</p>	<p>Drama activities were integrated into different portions of ELA lessons, such as acting out scenes (tableaux) to represent the sequence of the story. The study investigated the effect of this integration on teacher speech patterns and student on-task activity.</p>	<p>Teacher speech acts varied across the conventional language arts (CLA) and drama integrated language arts (CLA) activities; they were more likely to use assertive statements in DLA (p=.023/p=.002) and more likely to use regulatives in CLA (p=.044/p=.026). Requestives, responsives and directives did not vary significantly (p>.05 for each). Overall, student on task behaviour was not significantly higher in the DLA context, but five of the six outlier students (those most likely to be off-task) were more likely to be on-task during the DLA activities.</p>	<p>(i) Use of intact groups, (ii) small sample size, (iii) replicability of drama integration in other contexts is not clear, (iv) very particular and quite narrow scope of the research, (v) the interpretation of the data places more emphasis on outlier on-task behaviour than overall pattern in the data</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Anderson (2019) United States</p>	<p>This study adopted a tool available for testing efficacy beliefs for engineering education to assess efficacy beliefs for 21st century integration.</p>	<p>Scale development (questionnaire/piloting of scale; factor analysis)</p>	<p>Teachers from one school district (N=196); schools (N=7)</p>	<p>The teacher participants who contributed to the testing of the scale had taken part in PD on 'cross-disciplinary deep learning tasks', following the work of Drake and Burns (2004). The author distinguishes between 'intradisciplinary' work (integration within a discipline) and 'interdisciplinary work' (integration across disciplines). The definition of Hartzler (2000) is also endorsed (see page 23). 21st century integration is framed as including aspects such as citizenship, collaboration, communication, creativity etc.</p>	<p>The scale consisted of items arranged around three constructs: beliefs about integration; general efficacy beliefs towards integration; process efficacy beliefs towards integration. A bifactor model consisting of one general factor and two specific factors showed the best fit for the items/scale. In the view of the author, the scale is a valid and reliable tool for testing teachers' beliefs about integration.</p>	<p>(i) Study focused on scale development- the scale is not subsequently used as part of a survey or other study to determine attitudes towards/efficacy for integration</p>	<p>Doctoral Thesis</p>



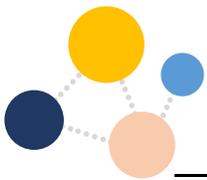
<p>Aranda (2020) United States</p>	<p>This study examined 'disciplinary discourses' in a design-based unit that focused on the integration of engineering into a 6th grade science unit on genetics. In particular, the study focused on the ways of knowing, doing, talking, reading, writing, and context within integrated science and engineering classes/units.</p>	<p>Case Study (Observations, Artefacts [lesson plans, curricular documents])</p>	<p>6th Grade Classroom (N=1)</p>	<p>The issue of curricular integration is considered in relation to the field of 'disciplinary discourses' (see Wallace, 2004). Disciplinary Discourses refers to all the ways student know, practice, talk and think about a particular subject. For this study, science Discourses and engineering Discourses, and a multidisciplinary Discourse of science and engineering were present. The authors did not offer any particular examination of the contents of science and engineering based multidisciplinary discourses other than to suggest that it may support increased understanding of both disciplines.</p>	<p>The teacher merged everyday and more technical disciplinary Discourses to scaffold the students' understanding. A high level of teacher knowledge (e.g., terminology use) and skill (e.g. knowing when to use this terminology) was observed to achieve this. Multidisciplinary Discourses between science and engineering emerged among students, suggesting that students can successfully integrate the two disciplines. However, students were more likely to use scientific terminology ('technical' discourse) than engineering terms (relying instead on 'everyday' engineering discourses).</p>	<p>(i) limited range of data gathered, (ii) sampling issues (volunteer, size/composition)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Atalay (2015) Turkey</p>	<p>Study examined the effects of an 'Integrated Curriculum Model' in a social studies classroom for gifted and talented learners. One class experienced an integrated approach to instruction involving a range of pedagogical methods, the other experienced a 'standard' approach instruction involving textbooks and lecture style teaching methods. Data was gathered at the start and end of the 8-week intervention.</p>	<p>Experimental Pre-Post Test with control group (Social Studies Achievement Test*, Cornell Critical Thinking Test, Torrance Test of Creative Thinking)</p>	<p>4th grade gifted learners (N=21)</p>	<p>Van Tassel-Baska's (1986) 'Integrated Curriculum Model' (ICM) informed the intervention. This approach has been specifically developed for gifted learners and consists of three inter-related dimensions in its enactment: advanced content, processes and products, and epistemological concepts. It involves the use of structured, real life problems using content and concepts that support connections between different disciplines.</p>	<p>Social Studies Achievement Test = Achievement was better in the experimental group ($p < .001$); Cornell Critical Thinking Test = Overall achievement was better in the experimental group ($p = .019$); Torrance Test of Creative Thinking = Overall performance in this test was better in the experimental group ($p < .001$)</p>	<p>(i) Researcher delivered instruction to the experimental group, (ii) Sample size and composition, (iii) control group's programme is poorly defined</p>	<p>Journal Article (Peer Reviewed)</p>



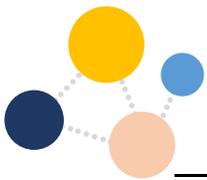
<p>Baker (2017) United States</p>	<p>This study reports the findings of a pilot professional development framework for integrating STEM into K-6 mathematics classrooms. The PD programme involved a 4-day 'summer institute' whereby university facilitators worked with 8 in-service teachers to implement a 'flexible and fluid professional development' experience that would support teachers' future work. The project had a particular focus on the role of mathematics and model-eliciting activities in STEM activities.</p>	<p>Design Based Implementation Research (Daily reflections; Recordings of task-based discussions; Teacher Efficacy and Attitudes Toward STEM Survey for Elementary Teachers (T-STEM))</p>	<p>In-Service Teachers (N=8)</p>	<p>Supported by the work of Vasquez et al. (2013), the authors conceptualise STEM integration on a continuum from multidisciplinary to interdisciplinary to transdisciplinary.</p>	<p>The daily tailoring of activities by PD facilitators based on participant feedback supported a more positive view and understanding of STEM integration for elementary classrooms. The use of MEAs as a pedagogy supported participants' understanding of how mathematics can be integrated more effectively within STEM tasks. By the end of the PD, participants indicated their readiness to use MEAs for STEM integration in their classrooms.</p>	<p>(i) T-STEM survey responses inadequately analysed/reported, (ii) generalisation of this model of PD could be somewhat limited, (iii) small sample size</p>	<p>Journal Article (Peer Reviewed)</p>
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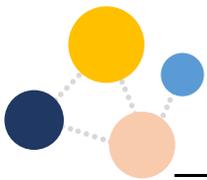
<p>Baptiste (2022) United States</p>	<p>This study described and examined the beliefs, instructional activities and curricular practices of teachers when teaching mathematics as a single subject and through an interdisciplinary curriculum that integrates maths with other subjects.</p>	<p>Qualitative phenomenological approach (Surveys [adapted from TALIS], Semi-Structured Interviews, Task Analysis [Teaching for Robust Understanding in Mathematics (TRU Math©) framework])</p>	<p>In-Service Teachers (N=13; includes HEI instructors)</p>	<p>The author uses the term 'interdisciplinary' to described integrated teaching. The author uses Williams and Roth's (2019, p. 14) definition whereby interdisciplinarity is a "multifaceted but partially nested system of concepts, where different forms of inquiry are situated at one or another level of complexity".</p>	<p>Several factors that informed the instructors' beliefs, practices, and activities about teaching mathematics and interdisciplinarity. Instructors felt strongly about helping students value learning and their abilities to do mathematics and seeing their students as capable problem solvers. Through their instructional activities, they sought to illuminate thinking and understanding of mathematics and make it meaningful. Analysis of teachers' practices in interdisciplinary teaching revealed that it occurred along a spectrum e.g. instructors teaching mathematics lessons for understanding (interdisciplinarity playing a minor role) vs instructors using interdisciplinary units to teach a particular concept/topic/theme where mathematics was used procedurally with little emphasis on conceptual understanding. The author summarised this finding by stating that interdisciplinary teaching seemed to occur in three main ways, where the teachers are constructors [learning mathematics (and making links with other disciplines) to maximise understanding], curators [teachers carefully choose when and how a pedagogy, practice, discipline, or subject lent itself well in the service of learning mathematics] or connectors [mathematics instruction involved explicit and implicit connections to other disciplines and subjects].</p>	<p>(i) teachers with varying levels of experience and backgrounds were included in the study - may make some of the findings difficult to generalise to primary settings, (ii) analysis of data was not always particularly clear, (iii) heavy reliance of self-reporting to support analyses of classroom practice (large inferential distance) (iv) validity/reliability issues on some measures e.g. score on TMU framework, (v) sample size</p>	<p>Doctoral Thesis</p>
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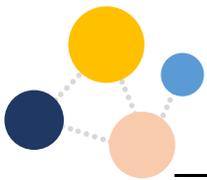
<p>Barnes (2018) Australia</p>	<p>A questionnaire was issued to schools that had participated in a sustainability programme which involved installing solar panels and smart meters. The researchers aimed to explore the extent to which schools drew on the smart meter interface as a resource for teaching about sustainability, given its positioning as a cross-curricular priority in the Australian curriculum.</p>	<p>Survey (researcher-designed questionnaire)</p>	<p>Survey responses (N=116): secondary/primary/early years teachers (n=66); school leaders (n=50)</p>	<p>The use of smart meter data is viewed through the lens of a cross-curricular priority (sustainability). There is limited attention to models of integration.</p>	<p>Most teachers had not used the smart-meter website to teach about sustainability; their school leaders were aware of it but its use had not trickled down to classroom practice. Other areas of the curriculum were prioritised for professional development (e.g. literacy). Where teachers *did* use the website, it was integrated with learning in the STEM curriculum, more specifically, science. The authors conclude that, on the basis of this study, sustainability is not getting the attention that it deserves as a cross-curricular priority.</p>	<p>(i) The focus of the study is somewhat constrained in looking only at schools that use smart meters, (ii) the questionnaire items do not appear to look more broadly at curriculum integration</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Bartels (2019) United States</p>	<p>This study looked at the progression of pre-service elementary teachers' understandings of STEM along with their ability to plan integrated science and mathematics lessons after explicit modelling and practice in co-planned methods courses. Two course instructors worked together to co-plan model STEM lessons for their preservice teachers to experience over the course of a single semester. The lessons were either 'mathematics-forward' or 'science-forward'. Pre-service teachers then had to design their own STEM units of work. The instructors gave feedback on these units before the pre-service teachers taught the lessons in different local elementary schools (observations conducted).</p>	<p>Mixed Methods (Pre-Post Scores on pre-service teachers' understanding of STEM), Observations of lessons taught)</p>	<p>Pre-Service Teachers (N=13)</p>	<p>No specific model of integration was discussed but the authors do highlight in their short literature review how mathematics and science content can be 'blended [sic]... to the point of being indistinguishable' (p. 667).</p>	<p>Pre-service teachers' understandings of STEM improved over the course of the unit. Their confidence in teaching integrated units also increased however, it should be noted that they often identified a topic first before aligning instructional standards (i.e. 'activity driven planning'). The authors also noted that the lesson plans implemented by the preservice teachers all had a near identical structure i.e. learners had to make a plan to build something, build, and then test it. Most of the lessons designed by the pre-service teachers were class as 'science forward'</p>	<p>(i) No literature review provided, (ii) Unclear conceptualisations of integration, (iii) Inadequate description of data analysis procedures</p>	<p>Journal Article (Peer Reviewed)</p>



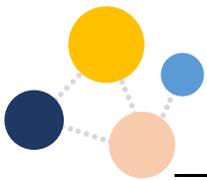
Batic (2020) Slovenia	<p>This is a qualitative study in which the classroom teacher (in collaboration with an art educator/researcher) integrated visual art and literacy through the use of picture books. A joint focus was placed on literacy concepts and art concepts. Students reported enjoying the picture book and art-making activities; they were more likely to draw on multiple modes of communicating in their post-intervention responses, in line with the joint focus on visual art and literacy.</p>	<p>Students responded to a researcher-designed questionnaire before and after each teaching unit, generated qualitative data; lessons were observed by the researcher; teacher evaluations of the unit</p>	<p>Convenience sample of pupils (fifth grade) (N=21), their classroom teacher and an art education research</p>	<p>Multimodality in picture books was the fulcrum for integrating literacy and visual arts</p>	<p>Students reported enjoying the integrated art/literacy activities and were more likely to draw on *both* visual/print-based resources in interpreting texts after instruction than beforehand; students were more likely to prefer creative activities like artmaking/poetry writing than the completion of worksheets;</p>	<p>(i) Outcome measures not included, (ii) the study is small in scale and circumscribed in scope, (iii) authors point out that the integration was limited in in only including two disciplines (literacy/visual art)</p>	<p>Journal Article (Peer Reviewed)</p>
Bazemore (2015) United States	<p>Spurred by poor performance in standardised measures of reading, third teachers in a Virginia school district embarked on integrating reading into the content areas. This study analysed (qualitatively) teacher perceptions of this integrated programme.</p>	<p>Case study (interviews; teacher feedback forms on student progress; analysis of school district plans; field/reflective notes from the researcher)</p>	<p>Grade 3 Teachers (N=13) from elementary schools (N=5) in a Virginia (USA) school district</p>	<p>The integration of content areas with reading in this study is informed by a constructivist approach and experiential learning (collaboration; research; communicating; problem-solving; critical thinking).</p>	<p>The themes constructed from the analysis of qualitative data underlined that teachers needed knowledge about how to teach reading, that collaboration amongst teachers supported this integration; that students reported benefits (e.g. interests; building of background knowledge) but also challenges (e.g. supporting struggling readers to access texts in the content areas)</p>	<p>(i) Small sample size, (ii) draws only on teacher self-report without significant triangulation with other sources (e.g. observations)</p>	<p>Doctoral Thesis</p>



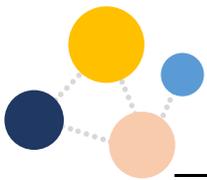
<p>Bergen-Cico (2015) United States</p>	<p>This study examined the impact of integrating yoga into ELA classes. Specifically, it compared scores on a measure of student self-regulation across an intervention group (yoga embedded ELA) and control group (which included some instruction on mindfulness, but not regular yoga).</p>	<p>Intervention with control group (Adolescent Self-Regulatory Inventory [measure of self-regulation]; weekly logs of practice/class time/reflections on the intervention; open-ended qualitative feedback from students/parents)</p>	<p>Children (N=144): mindful yoga intervention (n=72); active control group (n=72)</p>	<p>Yoga was embedded in English Language Arts classes. Though curriculum integration is included in the key words, very little conceptual attention is afforded to curriculum integration in the paper.</p>	<p>Students in the intervention group (yoga embedded ELA) had significantly higher self-regulation scores at mid-year ($F[1, 141] = 6.18, p < .05$) and year end ($F[1, 141] = 6.98, p < .01$), despite having similar baseline scores. In terms of feasibility, it took an average of 4 minutes per lesson, 3 times per week to implement the intervention. Qualitative teacher feedback indicated positive effects. 60% of students reported that they found yoga helpful; stating it helped to calm them down and improve concentration. The remaining 40% of negative responses pointed out that it led to a loss of instructional time; that it was not as effective at helping relaxation as envisaged or indeed that it caused them to feel *less* regulated. Parents were broadly positive about yoga integration.</p>	<p>(i) Statistical analysis does not fully account for the use of intact groups, (ii) individual differences in teachers (between the control/intervention group) may account for differences in scores - this is not accounted for, (iii) reliance on self-report data, (iv) potential Hawthorne effects, (v) relatively small sample size</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Betton (2018) United States</p>	<p>This study examined how seven middle school leaders (principals) supported the development of adolescent literacy in a cross-curricular manner. Drawing on a multiple site case study approach, school leaders shared the practices and leadership styles used in this endeavour.</p>	<p>Multiple Case Study (semi-structured interviews; documentary analysis)</p>	<p>Middle school principals (N=7)</p>	<p>The main consideration of integration is the use of 'interdisciplinary teams' at middle school level, which involves the formation of smaller groups supported by a core staff of teachers from multiple disciplines. Little attention is given to curriculum integration as a core concept, despite the focus on literacy teaching in a cross-curricular manner.</p>	<p>The author identifies that were five main findings: (i) participants felt unprepared to teach literacy standards in a cross-curricular manner, (ii) participants felt that they were supporting the literacy needs of adolescents in their schools, (iii) participants felt that their leadership styles supported change, (iv) change strategies were in use, (v) there were mixed views on how effective the implementation of cross-curricular literacy standards had been</p>	<p>(i) Small sample size, (ii) limited attention to curriculum integration</p>	<p>Doctoral Thesis</p>



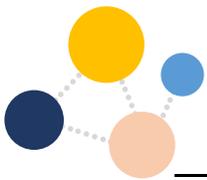
Birchinall (2013) Great Britain	<p>This study examined the thoughts and experiences of two cohorts of pre-service teachers who participated in a model of context-based learning. The study paid particular attention to the pre-service teachers' self-reported levels of engagement and motivation.</p>	<p>Case Study (Reflective Journals [blog posts])</p>	<p>Pre-Service Teachers (N=195)</p>	<p>The integration of content areas/curriculum guidelines is informed by a constructivist approach and experiential learning (e.g., collaboration; problem-solving; critical thinking). The term used to represent integration is this study is 'cross-curricular' which the author defines using Barne's (2011) work, stating that this is 'the application of skills, knowledge, and attitudes to a single experience, problem, question, theme or idea of a number of disciplines or subjects in a cross curricular way'</p>	<p>Pre-Service teachers' positive comments on experiencing a cross-curricular thematic week included: (i) appropriate context for collaboration, creativity and embedded learning, (ii) encourages engagement, constructivist thinking/activities, embedded learning, and the development of teacher expertise in pedagogy. Pre-Service teachers' negative comments on experiencing a cross-curricular thematic week included: (i) concerns over a lack of time, resources, and systemic supports (e.g. school leaders, government guidelines), (ii) comments that cross-curricular links were 'tenuous', (iii) inadequate subject knowledge, pedagogical knowledge and information to support planning. It appears that the context-based module did support engagement and motivation in pre-service teachers but they still had concerns about applying it to their own future classrooms despite these benefits.</p>	<p>(i) small data set - generalisability concerns, (ii) data quality, (iii) inadequate description of module, (iv) appropriateness of data analysis approach, (iv) suitability of inferences drawn is somewhat dubious (inferring what would work with primage school aged children based on the experiences of pre-service teachers)</p>	<p>Journal Article (Peer Reviewed)</p>
Birsa (2018) Slovenia	<p>This study presents the key findings arising from a piece of experimental research that examined the effects of teaching visual arts concepts (specifically sculpture) using cross-curricular integration approaches.</p>	<p>Experimental study with control; Treatment: n=160 students, 8 teachers; Control: n=114, 6 teachers (Researcher designed rubric)</p>	<p>5th grade children (N=274) and in-service class teachers (N=14)</p>	<p>Author stated that the approach to integration used in this study aligned with Fogarty's (2009) 'nested' approach- 'concepts previously acquired in another subject or subject area were used to assist in learning or revisiting the particularities of certain art concepts' (p. 197).</p>	<p>Students were observed and assessed under the following headings: motivation, creativity in solving the four sculpting tasks, and art concept comprehension (written examination/art products). According to the authors, the experimental group made more progress than the control group in creative engagement in the implementation of the sculpting tasks, as reflected in the grades achieved by students in sculptural works - this was the greatest difference in scores noted between the treatment and control groups. Measures related to student motivation indicated that students in the experimental group were more motivated than their peers in the control group.</p>	<p>(i) Inadequate discussion on how a range of potential confounders/biases were controlled for, (ii) suitability of outcomes measures, (iii) inadequate reporting of statistical analyses (e.g. assumptions)</p>	<p>Journal Article (Peer Reviewed)</p>



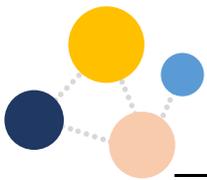
Björklund (2017) Finland, Sweden	This survey examined the self-reported approaches employed by Finnish and Swedish early childhood educators in constructing and implementing thematically organised integrated units of mathematics and art.	Qualitative (Survey with open-ended items)	In-Service Teachers (N=27)	The authors note that 'thematic work in education means the integration of different knowledge areas, with some common phenomena used as a frame for developing knowledge and skills' (p. 99). This definition is heavily influenced by Dewey. The authors take care to highlight that cross-curricular teaching is distinct to thematic teaching (but does not go into significant detail as to why that may be the case).	The authors identified 4 main approaches that the teachers used when teaching mathematics integrated with art in thematic units of work: process-oriented (processing mathematical content via art-based activities), product-oriented (prioritising the learning of key facts/knowledge/concepts), development-oriented (focus on conceptual understanding and its application to multiple contexts and disciplines) and providing awareness (discovering mathematical phenomena in everyday life).	(i) sample size, (ii) inadequate discussion on arts/mathematics integration	Journal Article (Peer Reviewed)
Boche (2021) United States	This study examines how PSTs enacted integration on placement, following participation in an ITE programme that was restructured to support integrated teaching.	No design named, but similar to a case study (field experience lesson plans; survey; video-recorded lessons)	Preservice teachers (N=12) participating in one ITE programme	Integration is framed according to Stoddart et al.'s model (2002), which identifies three conceptualisations a) thematic approach; b) interdisciplinary approach; c) integrated approach. In this study, an interdisciplinary framed as one subject being of less weight than the other (e.g. some reading being integrated into a social studies lesson); integrated or 'full integration' is framed as affording equal weight to both. The integration of more than two areas is not fully considered.	Analysis of PSTs' preparation indicated that the majority did not integrate their teaching in any way during their field experiences. Interdisciplinary integration was next most common, usually involving linking reading or writing with content area learning. A smaller number had what the authors term 'full integration' in which subjects are balanced. There was variation in PSTs' understanding of integration, demonstrating at least some lack of explicit knowledge on this topic. The authors recommend that integration must be explicitly addressed in ITE modules and then linked with observation/teaching on placement. Reflection on both is also advised. Clear connections must be forged between the ITE provider and partner schools.	(i) Authors were evaluating their own/students' practice, (ii) potential issues with reflexivity/distance from the case, (iii) one case with a small number of participants	Journal Article (Peer Reviewed)



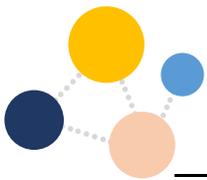
<p>Brand (2012) United States</p>	<p>During an ITE programme, pre-service teachers were taught about interdisciplinary learning in which they planned units of work that drew on concepts from across several disciplines. Post-graduation, this study followed up to see how these teachers drew on interdisciplinary pedagogies in their first year of teaching.</p>	<p>Survey (open-ended responses)</p>	<p>Practicing teachers (K-5) who were formerly pre-service teachers on a programme that integrated science/literacy (N=25)</p>	<p>Study was informed by constructivist principles; while undertaking their ITE programme, pre-service teachers planned instruction that linked concepts from several disciplines. This survey followed up post-graduation to analyse their perceptions of integration.</p>	<p>Two main categories of findings were presented (planning and implementation; constraints) with several sub-categories. Key findings included that teachers found it difficult to integrate more than two disciplines (often integrating literacy with one other subject); that teachers reported student benefits from this form of teaching (e.g. better student engagement/understanding; better recall for information; better enjoyment of content); that excellent teacher collaboration is needed for integration to work; and that ITE that focussed on integration supported practice as a first year teacher. A number of constraints were also identified (see challenges field).</p>	<p>(i) Small sample, (ii) researcher bias is possible as the teachers were former students of the authors - this is not given considerable attention/weight in the study, (iii) limited tools that rely on teacher self-report</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Bravo (2014) United States</p>	<p>This study adopts a quasi-experimental approach to determine how science-literacy integration benefits English learners. Children in the intervention group took part in a series of 40 sessions built around a unit on space, balancing first-hand/inquiry approaches and literacy-focused activities. Children in the comparison group took part in science lessons based on the same content.</p>	<p>Quasi-experiment (measures of science understanding, vocabulary and reading comprehension [all designed by the researchers]; observations; interviews)</p>	<p>Els (N=115) from the classrooms of teachers (N=10), in different schools (N=5)</p>	<p>This study focuses on the explicit integration of language/literacy content in science lessons, with a view to supporting the learning of English learners. The study is not framed around curriculum integration per se.</p>	<p>On the basis of observational data, the researchers conclude that linguistic development was better supported in the environment of intervention group classes, due to an increased focus on oral communication and sense making. Students in the intervention group had significantly higher scores in science understanding $g (F = 5.46; p < .05)$ and vocabulary $(F = 11.019; p < .001)$. There was no difference in science reading comprehension. This pattern was replicated when focussing only on the outcomes for ELs.</p>	<p>(i) The authors identify homogeneity in the languages of the EL (mainly Spanish) as a limitation and the limited amount of time spent observing, (ii) little attention is given to the curricular implications of integrating literacy in this way, (iii) query if more advanced statistical modelling may have better accounted for the findings presented, rather than ANOVA analysis</p>	<p>Journal Article (Peer Reviewed)</p>



<p>Brough (2012) New Zealand</p>	<p>This study used participatory action research to examine the principles and practices of student-centred curricular integration across three classrooms in New Zealand.</p>	<p>Participatory Action Research (Focus Groups, Interviews, Naturalistic Observations, Work Samples)</p>	<p>In-Service Teachers (N=3) working with their students (N=75 approx.)</p>	<p>The historical origins of curricular integration were discussed and described using two broad conceptualisations: subject centred CI ('multidisciplinary') and student-centred CI. In this study, student centred CI is examined according to three key principles and practices: use of relevant learning themes, co-constructed curriculum and the role of the teacher.</p>	<p>Five themes were constructed from the data gathered: (1) pedagogy and practice, (2) skilful questioning, (3) building a sense of community through shared decision making, (4) co-constructed curriculum; and the (5) challenges of student-centred CI. Regarding Theme 1, the author noted that while teachers had a very good understanding of democratic pedagogies, there was often a 'mismatch' between policy and practice as teachers often retained ownership over decision making and curriculum. This changed over the course of the project as teachers became more comfortable with the use of democratic pedagogies in practice. Questioning (Theme 2) was a key theme as the way that teachers asked questions could empower or disempower students. The author noted that teachers developed a sense of community through shared decision making (Theme 3) by first involving the students in 'low stakes' decisions before progressing onto more complex decisions. Two approaches to a co-constructed curriculum (Theme 4) were discussed by the participants: 'co-constructed planning within predetermined themes' and 'co-constructed planning from student-initiated themes'.</p>	<p>(i) Some data collection tools were poorly described (e.g. naturalistic observations), (ii) Some contextual data was poorly described (e.g. nature of teachers' experiences, what subjects/content was involved in the CI activities) (iii) a greater range of data sources would have been useful</p>	<p>Journal Article (Peer Reviewed)</p>
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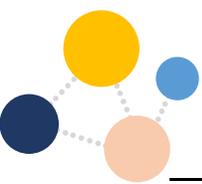


<p>Brugar (2012) United States</p>	<p>This study took place in a curricular context (US) in which social studies and visual arts were less likely to be taught due to testing requirements in literacy and numeracy. Two teachers implemented an interdisciplinary history-literacy-visual arts unit; student outcomes were compared to those in a comparison class.</p>	<p>Quasi-experiment - two intact experimental classes, one comparison (researcher-designed assessment of state standards [pre/post]; observations; analysis of work samples; teacher interviews)</p>	<p>Fifth grade students (N=50): intervention group (n=27); control group (n=23)</p>	<p>The author refers to Jacobs (1991) to define interdisciplinary instruction: "a knowledge view and curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience" (pp. 22–23). The author points out that they use the terms interdisciplinary and curricular integration interchangeably throughout the thesis. Lessons in the instructional unit addressed at least one standard from history and language arts, visual arts is not as clearly represented.</p>	<p>Analysis of the researcher-designed assessment demonstrated that students scored significantly higher in the intervention classes than in the comparison class ($t(48) = 4.160, p = .000$, Cohen's $d=1.02$). Improvements were also noted in individual assessment items (matched with state standards), though, on average, they did not reach full proficiency on these standards. Qualitative observational data indicated that students demonstrated both substantive and procedural engagement during interdisciplinary lessons. Students demonstrated aesthetic development (relating to visual arts integration) and historical thinking at a variety of levels in their classroom contributions. Teachers noted a number of benefits: (i) student engagement, (ii) promotion of higher order thinking skills and (iii) teacher learning (e.g. their own interest and ownership grew over time). A number of challenges were also identified: (i) lack of time (ii) teacher preparedness (teachers invested little time ahead of teaching on preparing the unit's work; finding appropriate resources), (iii) knowledge of interdisciplinary instruction (vague conceptualisations; strict disciplinary boundaries in timetabling)</p>	<p>(i) Use of intact classes, (ii) comparison class in a different school, (iii) high level of support provided in instructional materials, (iv) potential research bias in evaluation of their own materials, (v) use of researcher-designed and unvalidated measures, (vi) sample size</p>	<p>Doctoral Thesis</p>
<p>Brugar (2017) United States</p>	<p>The researchers in this study observed how social studies was integrated throughout both academic (e.g. science/ELA) and non-academic (lunch) periods of the school day. They provide examples of how social studies appeared in contexts other than timetabled social studies slots.</p>	<p>Case study (observations of teaching; semi-structured interviews)</p>	<p>Elementary social studies teachers (N=2)</p>	<p>This study frames integration according to the work of Hinde (2015): healthy social studies integration happens when ELA is used to support social studies content; fractured integration happens when it serves to boost ELA learning (rather than social studies learning); stealthy integration happens when social studies content is masked as ELA content.</p>	<p>Social studies was regularly integrated during non-academic times, such as during school announcements at the start of the day or during snack time. During ELA time, it was regularly presented in the context of historical fiction, while maths one example included the use of maps during the plotting of points on a coordinate plane. The authors conclude that social studies integration needs to be done on an explicit basis so that students are aware of its status and their learning.</p>	<p>(i) Sample size, (ii) highly specific to the US context, (iii) the activities being labelled as 'social studies' may be something of a stretch - further conceptual framing needed</p>	<p>Conference Proceedings/ Papers</p>

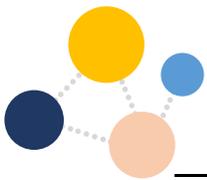


<p>Bryant (2012) United States</p>	<p>Students in the treatment group of this study had their fluency instruction supplemented with musical strategies over the course of eight weeks, e.g., singing, clapping, body percussion, found instruments. Other music-integrated fluency instruction included the use of ascending/descending scales to match speech intonation patterns (e.g. to signal questions). Students in the control group also received fluency instruction, but without the musical elements.</p>	<p>Quasi-experiment; students in one school took part in the intervention, students from a different school took part in the control (DIBELS reading fluency test scores [phoneme segmentation fluency; nonsense word fluency]);</p>	<p>First graders (N=115): treatment group (n=55) (three classes); control group (n=60)(three classes)</p>	<p>This study relies on the idea that reading and music share underlying cognitive processes, captured in LaBerge and Samuels' (1974) automatic information processing model. The study takes place in the context of limited instructional time being dedicated to non-literacy/numeracy endeavours in US schools, providing a rationale for integrating music with reading. No conceptual or curricular framework for integration is provided.</p>	<p>Comparison of post-test scores indicated that there was no significant difference between treatment and control groups on the DIBELS nonword fluency measure $t(111) = 1.437, p = 0.154, d = 0.273$ but that there was a significant difference for the DIBELS phoneme segmentation fluency measure $t(111) = -9.191, p = 0.000, d = 0.747$ (favouring treatment students). In the case of the former comparison, the author indicates that post-hoc power analysis indicated that there was insufficient statistical power to identify differences in scores.</p>	<p>(i) Use of intact classes/groups, (ii) no mention of the music curriculum - very large focus on the literacy curriculum, (iii) no measure of musical outcomes adopted, (iv) no observation/reliance on teacher self-report of fidelity measures, (v) the statistical analyses do not account for nested data; (vi) limited conceptual explanation for the significant/non-significant findings [beyond pointing to issues with statistical power]</p>	<p>Doctoral Thesis</p>
<p>Bungum (2014) Norway</p>	<p>This case study describes how mathematics was integrated and used in a practical technology project with a group of nine-year olds (as guided by their teacher). The technology project required students to design and make a model of a simple building that would serve as a shelter in a nearby nature area.</p>	<p>Case Study (Observations; Interaction Analysis)</p>	<p>Students in a multi-grade classroom (Grades 3-7; N=13), Class Teacher (N=1)</p>	<p>Technology and Design' is a cross-curricular topic with specific competence aims in mathematics, science, and arts and crafts from grade 1 to 10. This study examines how mathematics was utilised to address this cross-curricular topic.</p>	<p>Interactions were classified according under the headings of instructive and intervening ('Exercise Paradigm'), or explorative and moderating ('Landscapes of Investigation' Paradigm'). The authors found that the teacher found it difficult to move beyond instructive or intervening comments when teaching key mathematical concepts despite having an appropriate culture for investigation present in their classroom. Difficulties in moving beyond the 'instrumentalist' view of mathematics when engaging in meaningful activities (e.g. fear of taking risks etc.).</p>	<p>(i) inadequate discussion of potential confounders (e.g. multi-grade setting, student characteristics, teacher characteristics etc.), (ii) small sample size, (iii)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Byrd (2019) United States</p>	<p>This study compared the achievement of fifth grade students in two conditions: arts integrated and traditional instruction. The study draws on</p>	<p>Pre/post with comparison group (teacher interviews; classroom observations; pre/post</p>	<p>Fifth graders (N=180) in two different schools: (n=94) fifth</p>	<p>This study is grounded in the literature on arts-integrated curriculum. The following definition is provided, drawing on Demoss & Morris (2017) and</p>	<p>(i) a number of benefits of arts integration were highlighted; teachers stated that it supported student engagement/excitement and reduced behavioural issues; this was supported by</p>	<p>(i) Statistical analyses pay limited attention to the use of multiple comparisons and nested data, (ii) the</p>	<p>Doctoral Thesis</p>

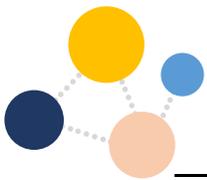




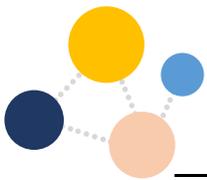
	qualitative and quantitative measures, each of which provide conflicting findings.	GPA scores; pre/post writing samples assessed using the 6+1 Traits of Writing rubric; pre/post ELA grades)	graders in the arts-integrated group; (n=95) in the traditional instruction group	the Kennedy Centre: "An approach to teaching that integrates the fine and performing arts as pathways to learning. The John F. Kennedy Center for the Performing Arts further defined arts integration as an approach to teaching in which students construct and demonstrate understanding through an art form (DeMoss & Morris, 2017)". Cross-curricular learning is mentioned in the context of STEAM curriculum, with STEAM characterised as "the belief that students need a natural and creative view of the world to compete in the twenty-first century global economy (Sousa & Pilecki, 2013)" (p.20). The policy context/impetus for integration stems from the effects of the NCLB and subsequently the ESSA.	observational data, (ii) weaknesses were also highlighted, such as the limited time for collaboration with other teachers, the impact of state testing, and the lack of professional development for this endeavour, (iii) no statistically significant difference was found between arts-integrated and traditional instruction groups in the following measures: GPA gain scores, 6+1 Traits of Writing scores, ELA grade gain scores.	author suggest that a longer time period may have given rise to statistically significant differences, (iii) limited information on the methods/approaches being used in both conditions, (iv) lack of clarity around role of researcher in supporting teachers	
Calder (2013) New Zealand	Using three different case studies, this paper examined how mathematical understandings might emerge through student-centred inquiry that is based on the ideals of cross-curricular/interdisciplinary units of work.	Multi-Site Case Study involving Participatory Action Research (semi-structured interviews, focus group meetings, informal discussions, naturalistic observations, work samples, and photographs)	In-Service Teachers (N=3)	The authors discuss 'student-centred curriculum integration'. Aligned with Beane's (1997) approach, the authors state that 'student-centred curriculum integration is a democratic teaching approach where relevant and meaningful contexts are central to curriculum design' (p. 1). The authors identify key themes for integrated instruction: (i) themes should be organised around problems and issues (Beane, 1997), (ii) Use of a negotiated curriculum (Fraser, 2000), (iii) Teacher as a facilitator (Cook, 1996)	Based on the data gathered and analysed, the findings indicated that mathematics centred on real-life learning was highly engaging and that the measurement and geometric thinking explored went beyond New Zealand curriculum requirements for each teacher's age group. It also appeared that their experiences also encouraged them to apply their investigative strategies beyond their own classroom e.g., calculating the volume of the swimming pool	(i) small sample size, (ii) lack of diversity regarding the type of data gathered limits interpretations, (iii) researcher bias and subjectivity	Journal Article (Peer Reviewed)



<p>Cannon-Ruffo (2020) United States</p>	<p>This study compared the cognitive and affective outcomes of learners' participation in an integrated STEM curriculum involving educational robotics. The intervention consisted of 10-12 sessions and used Lego MindStorms EV3 robotics kits.</p>	<p>Quasi-experimental study with non-equivalent pre-post-test design; Treatment Group: n=45, Control Group: n=35 (STEM Achievement Assessment [researcher-designed; cognitive], PEAR Common Instrument Suite [affective])</p>	<p>4th Grade learners (N=80)</p>	<p>The author notes that STEM can be considered a 'meta-discipline' whereby the inter-relatedness of the four disciplines can be explored using project or problem-based learning within a real-world context. The use of educational robotics within this approach to STEM is heavily influenced by constructionism.</p>	<p>Results indicated that the intervention was associated with higher STEM achievement (Cohen's $d=1.12$) and perseverance (Cohen's $d=0.45$). There were no statistically significant gender main effects or interaction effects for either cognitive or affective outcomes.</p>	<p>(i) non-equivalent groups and intact groups (selection bias), (ii) commercial kits used (Lego), (iii) short duration of intervention (<3 weeks), (iv) some statistical analyses may not have been appropriate to conduct given the violations of certain assumptions</p>	<p>Doctoral Thesis</p>
<p>Capobianco (2014) United States</p>	<p>This study investigated 5th and 6th grade STEM teachers' planned and implemented engineering design-based instruction.</p>	<p>Case Study (Observations using an adapted version of Inquiring into Science Instruction Observation Protocol (ISIOP); Document Analysis using an adapted version of Penn Science Teacher Institute's Science Lesson Plan analysis Instrument (SLPAI) [Lesson Plans])</p>	<p>In-Service Teachers (N=23)</p>	<p>The integration of the four STEM disciplines was not discussed in this paper. Instead, the paper focused on how this integrated approach could be introduced to classrooms using Rogan's (2007) theory of curriculum implementation as a theoretical framework.</p>	<p>The design of the lesson plans demonstrated strength in direct links to state science standards (science content) and design process standards (engineering practices), alignment of engineering conceptual understandings (vocabulary associated with the engineering design process), and the portrayal of engineering practices (students' engagement in a design task). Areas of weakness in the plans mainly centred around science conceptual understandings (key science vocabulary and its placement, use, and application within a design task). Classroom observations indicated that teachers tended to "front load" the design process by concentrating more of their instructional time on problem identification and planning and less time on testing designs, communicating performance results, and redesigning. The authors noted that there were two key shortcomings in teachers' implementation of the engineering design process in STEM lessons: (i) completing the different phases of the engineering design process and (ii) applying scientific principles during the task.</p>	<p>(i) generalisability concerns (study involved specialist STEM teachers), (ii) researcher bias (long term study with sustained support from researchers)</p>	<p>Journal Article (Peer Reviewed)</p>

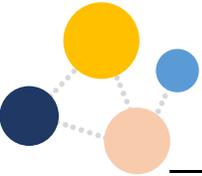


<p>Casady (2015) United States</p>	<p>This study examined differences in the achievement of fourth graders taught in an experimental interdisciplinary condition and a more traditional, subject-based condition. Teaching took place over the course of one school year (August to May). The researcher was the classroom teacher for the interdisciplinary condition.</p>	<p>Quasi-experiment drawing on intact groups/classes, 1 treatment and 2 control (pre/post assessment of social studies [district constructed multiple choice/short answer] and English/Language arts [Renaissance learning STAR assessment of comprehension/vocabulary]; post assessment only of science [district constructed assessment]; student questionnaire administered pre/post; interviews with school administration)</p>	<p>Fourth graders (N=53); two intact fourth grade classes served as the control (each n=19); one intact class served as the treatment class (n=15)</p>	<p>Drake's (2012) explanation of integrated/interdisciplinary curriculum is adopted: it ""revolves around a common theme, issue, or problem, but interdisciplinary concepts or skills are emphasized across the subject areas rather than within them"; the 'know-do-be' framework was key to the design of the integrated curriculum units.</p>	<p>Quantitative data: (i) t-test analysis demonstrated that science scores post-intervention were significantly higher in the integrated condition (p<.001), (ii) ANOVA analysis of social studies scores indicated significant differences (p<.001), with the integrated condition showing greater growth, (iii) ANOVA analysis of ELA scores indicated that there was no significant difference between groups. Qualitative data: analysis of questionnaire responses pre and post led the author to conclude that students in the integrated condition had a greater appreciation for social studies; administrators were generally positive about their experiences.</p>	<p>(i) Science scores were not gathered prior to the intervention - it cannot be ascertained if higher scores in the treatment group can be attributed to the intervention, (ii) researcher effect cannot be ruled out - the gains in the integrated condition may be attributable to teacher differences rather than mode of delivery differences, (iii) qualitative analysis is quite superficial, (iv) potential for researcher bias in reporting of some of the qualitative data (e.g. relationship with administration may affect the answers provided);</p>	<p>Doctoral Thesis</p>
<p>Cassidy (2022) United States</p>	<p>This study describes how two middle school teachers implemented the BioRobots curriculum to support an integrated approach to STEM education. This curriculum 'interweaves engineering, biology, robotics, and computational thinking (CT) through a design task' (p. 235).</p>	<p>Case Study (Teacher Interviews; Teacher Logs; Observations)</p>	<p>In-Service Teachers (N=2; middle school teachers of science and</p>	<p>The authors discussed interdisciplinary learning in general, historical terms and identified key studies that supported the use of integrated STEM units in advancing student outcomes. They provided a tabular overview of how the integrated unit was planned and enacted, with specific reference to the science, math and engineering practices that were being addressed in each lesson.</p>	<p>The authors found that the teachers enacted the curriculum according to their own disciplinary perspectives e.g. Teacher A (Science Teacher) emphasised the biological features of the problem, Teacher B (Engineering Teachers) emphasised the engineering design process.</p>	<p>(i) differences in implementation may have been due to environmental factors (e.g. year-long vs semester-long approach), (ii) researcher bias/selection bias, (iii) generalisability</p>	<p>Journal Article (Peer Reviewed)</p>

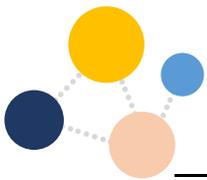


<p>Cecchini (2020) Spain</p>	<p>This study examined the effects of an interdisciplinary educational approach integrating physical education and mathematics on light and moderate-vigorous physical activity (PA), sedentary behaviour, and learning subtraction</p>	<p>Quasi-experimental study with control group and pre-post data: Treatment Group: n=23, Control Group: n=23 (Subtraction Test from Yáñez & Bethencourt [2004], data from GT3X Activity monitors)</p>	<p>1st Grade Students (N=46)</p>	<p>Fogarty's (1991) shared model was used as a framework to guide the design of the integrated curriculum used in the PE/ Mathematics intervention.</p>	<p>Students from the treatment group reached higher levels of light PA (d = 2.97), moderate-vigorous PA (d = 2.35), and spent less time in sedentary behaviour (d = 4.01), than students who attended regular classroom lessons. Moreover, the students from the treatment group achieved higher scores in subtraction learning than the control group (d = 1.20).</p>	<p>(i) relatively short intervention period (3 weeks), (ii) generalisability concerns (e.g. subject specialist rather than generalist teachers were involved, sample size), (iii) intact groups</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Cervetti (2012) United States</p>	<p>In this study, students/teacher undertook a model of integrated science and literacy instantiated in the topic of light. Students/teachers in the control group implemented business as usual teaching of similar content. Students engaged in work that balanced both first hand inquiry and literacy skills about the topic.</p>	<p>Experiment (researcher designed [but validated] measures of science understanding; science writing measure; vocabulary measure; reading comprehension measure)</p>	<p>Fourth grade classrooms/teachers (N=94)</p>	<p>Refers to Stoddart et al.'s (2002) three approaches for integrating content areas, locating this study as one that falls within the 'integrated' approach: learning in both domains is balanced. Science and literacy were viewed as having "mutually reinforcing relationships" in which first-hand and text-based learning are balanced.</p>	<p>Moderate effect sizes for science learning (ES = .65); small effect size for vocabulary (ES = .22); moderate multivariate effect for writing dimension (ES=.40)</p>	<p>(i) Short-term - effects only measured over course of one unit, (ii) Self-report of fidelity measures; (iii) highly scaffolded integration that may not be replicable by teachers on their own</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Chand O'Neal (2017) United States</p>	<p>This large-scale, longitudinal study examines the effects of arts integration on student creativity, engagement and academic outcomes. The study involved a comparison of learners involved in the Changing Education through the Arts (CETA) program with children at matched control schools using traditional classroom instruction.</p>	<p>Longitudinal, quasi-experimental design involving multi-group analyses i.e. outcomes were examined at the student level (self-report), parent level (parent perceptions of their child's creativity and engagement in schoolwork), and teacher level (teacher perceptions of their student's creativity and engagement in schoolwork) (Runco Creativity Assessment Battery; Chand-O'Neal & Schulz Begle Student Engagement Survey; Standardised Test</p>	<p>4th/5th Grade Learners (N=746); In-Service Teachers (N=86); Parents (N=746); Treatment: n=552 students, Control: n=194 students</p>	<p>The author does not discuss in detail how arts integration can be conceptualised in elementary school curricula. They instead note that 'teaching through arts' is the position that informs their study 'as it provides a framework for understanding the cognitive, social, and educational value in pairing the teaching of required core content with and through the simultaneous teaching of an art form' (p. 7).</p>	<p>Key findings demonstrated that on dimensions of creativity, students receiving arts integrated instruction reported a greater increase in positive attitudes about artists over the course of the study compared to matched controls. Students receiving arts integrated instruction reported little change in Engagement subscales (Interest, Effort, and Challenge) over the course of the study while students who did not receive arts integrated instruction showed an increase in their Interest and Effort scores over time, and a decrease in Positive Challenge scores over time. Teachers in arts integrated schools reported a greater increase in their students' effort and global scores of Teacher Evaluations of Student Creativity, student's Creativity Core and Social Creativity over the period of the study compared to teachers in the control schools. There were no significant</p>	<p>(i) unequal group sizes, (ii) pre-test scores indicated that baselines between schools were very different on a range of measures, (iii) state-based standardised tests can be problematic to interpret, (iv) students had been involved in CETA since Kindergarten and the cumulative effects of that were not clearly elicited in the research</p>	<p>Doctoral Thesis</p>

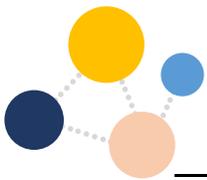




					Scores in Reading and Math)	differences for parent reports of student engagement or creativity between treatment and control groups across time. No significant differences were found in Math and Reading standardized test scores between the treatment and control groups. However, examination of the descriptive statistics seemed to indicate that students in the control group showed a greater increase in Math scores across time, whereas students in the treatment group showed a slight decrease in those scores over time. In Reading, standardized scores for the control group increased significantly while scores for the treatment group significantly decreased from previous year to intervention year.		
Collins (2016) United States	This study examined how implementing a researcher-designed, one-week science integrated curriculum resource could be an effective tool for improving preschool teachers' attitudes and beliefs toward teaching science.	Case Study (Observations; Interviews; Surveys [Preschool Teachers' Attitudes and Beliefs toward Science teaching (P-TABS)]; Artefacts [Lesson Plans])	In-Service Early Childhood Educators (N=4)	Using Gresnigt et al.'s (2014) framework as a guide, the author states that the thematic, multidisciplinary conceptualisation of integration is the 'optimal pedagogical approach' for early childhood educators. The author argues that this approach allows subjects to 'retain their integrity' but that their 'juxtaposition' still allows for meaningful connections to be made.		The study demonstrated that teacher attitudes and likeliness to use science in a preschool classroom were positively influenced by a science integrated curriculum supplement. However, it should be noted that many of the teachers involved were already positively predisposed towards the inclusion of science in early childhood settings. In particular, the author highlighted that teacher comfort is enhanced when the any supplied resource contains most of the information required to teach science (thus reducing the amount of research required and preparation time for science). Teacher comfort is a strong predictor of teacher practice.	(i) researcher designed (non-validated) curriculum materials, (ii) sample size and sampling technique (convenience), (iii) data analysis was somewhat simplistic	Doctoral Thesis

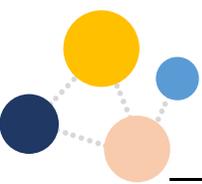


Colton (2016) United States	This study examined how the leadership styles of two principals supported and influenced teacher reported feelings of self-efficacy when delivered arts-integrated programmes.	Case Study (Surveys [Researcher-Designed Questionnaire]; Interviews; Observations [performances, posters about the integrated arts program and upcoming events, student work, and classrooms])	In-Service Teachers/Principals (N=12) from two schools	The author offers an overview of several different models of arts integration (e.g. Bresler etc..) but decides to define arts integration as a 'pedagogy that emphasises the importance of combining and making connections between an arts (music, visual art, dance, and drama) subject with and another content subject (math, science, social studies) to create a consolidated curriculum where learning takes place in both content areas' (p. 16).	Findings derived from questionnaires (designed using Bandura's (1994) work on self-efficacy Bass and Avolio's (1990) work on transformational leadership), interviews, and observations revealed that higher levels of teacher self-efficacy were likely influenced by a principal's use of a transformational style of leadership e.g. use of 'Idealized Influence', 'Inspirational Motivation', 'Intellectual Stimulation', 'Individual Consideration' etc.	(i) researcher designed materials, (ii) large inferential 'leaps' when one considers the data gathered, (iii) sampling approaches unclear and sample size was small (and may therefore be inappropriate), (iv) range of data gathered was somewhat limited and poorly defined (e.g. observation data)	Doctoral Thesis
Convertini (2020) Italy	This study examined pre-school aged children's inferential reasoning in STEM tasks.	Qualitative (Observations)	Pre-School Learners (N=25)	The author does not discuss any conceptual framework that discusses the integration of each of the STEM disciplines, despite using activities that involved science, engineering and maths concepts.	The study demonstrated that young children are able to reason about the possibility/ impossibility to achieve the goal of a STEM activity in relation to the available tools. They were able to: 'reason about valid alternatives to solve a problem, think about the possible negative consequences of an action, to predict future conditions, and to reason about instruments that prevent reaching a goal' (p. 183). They also demonstrated perspective taking.	(i) no underlying framework to explain the design of the three tasks, (ii) researcher bias	Journal Article (Peer Reviewed)
Corlu (2014) Turkey	This study examined the self-reported readiness of Turkish pre-service teachers to facilitate integrated mathematics and science lessons to primary-age learners.	Quasi-experimental (Survey; Dogan's (1999) Attitudes Survey)	Pre-Service Teachers (N=226); Group A (Integrated Teacher Education): n=69. Group B (Departmentalised Teacher Education): n=154.	Conceptualisations of curricular integration are not discussed in this paper. Instead the authors offer this definition of STEM education from Corlu et al. (2014, p. 75): STEM is defined as the set of "knowledge, skills and beliefs which are collaboratively constructed [by students and teachers] at the intersection of more than one STEM subject area".	The impact of the integrated university curriculum is noteworthy for pre-service mathematics and science teachers' attitudes when compared to pre-service mathematics teachers in the departmentalised program (Cohen's d=0.53).	(i) intact groups, (ii) unequal sample sizes, (iii) instrument was somewhat problematic in design (e.g. language issues etc.),	Journal Article (Peer Reviewed)

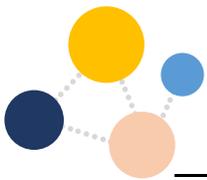


Cotič (2021) Slovenia	This study examined the effects of an integrated, cross-curricular approach to teaching mathematics and science with experiential learning techniques on the knowledge of 3rd grade primary school pupils in Slovenia.	Non-randomised quasi-experimental design (Pre-Post Data with control; Researcher-designed test materials [aligned with TIMMS domains]; Treatment: n=149, Control: n=155	3rd Grade Learners (N=304)	No particular definition or discussion on the concept of curricular integration was presented by the authors. A brief summary of the purported advantages of cross-curricular integration was provided with the authors stating that cross-curricular integration 'improves school performance, facilitates deeper understanding and knowledge application, fosters sustainable knowledge and prepares the child for lifelong learning' (p. 3134).	No statistically significant differences between the treatment and control groups on items related to factual knowledge were noted. Regard the domains of 'conceptual understanding' and 'reasoning and analysis', statistically significant differences were identified for both (p = .003, p= .016). On both domains, students in the treatment condition outperformed the control condition.	(i) intact groups, (ii) short intervention (3 hours!), (iii) researcher designed materials, (iv) intervention was poorly described - difficult to determine what features it included beyond the term 'experiential learning'	Journal Article (Peer Reviewed)
Coudriet (2013) United States	This study examined teacher and principals' perceptions, attitudes and beliefs regarding the role, practice and context of elementary art, music and physical education teachers in supporting the current aims of public education in the United States. These teachers were purposefully chosen given that 'art, music and physical education teachers have been asked to integrate content from the tested content areas of reading and math or to engage in pedagogical approaches that foster 21st century skills' (p.4).	Multiple-Site Case Study (Interviews; Artefacts e.g. g teacher schedules, lesson plans, field notes)	In-Service Teachers and Principals (N=13)	This study was informed by Bresler's (1995) work on arts integration. Bresler (1995) described 4 approaches to Arts Integration in schools: subservient, co-equal, affective, and social. Other models of integration were also invoked in this study (e.g. Cone et al.'s 2009 models for PE Integration) but Bresler's (1995) was the lens through which the author analysed their data. The author also states that, more generally, interdisciplinary learning involves 'the simultaneous and mutual use of knowledge to support learning through two or more content areas' (p.34).	Participants' interdisciplinary teaching practice was influenced by factors including: perceived curricular hierarchy, concerns with declining student creativity, awareness of school accountability requirements, self-efficacy, resources, value of integration and principal support.	(i) study involved specialist teachers in PE, Art and music (generalisability), (ii) small sample size, (iii) self-report data	Doctoral Thesis
Cunnington (2014) United States	This study investigates the impact of the 'Framing Student Success: Connecting Rigorous Visual Arts, Math and Literacy Learning' project, which delivered interdisciplinary visual arts, maths and literacy instruction in New York City Title 1 (high poverty) schools. A cluster randomised trial was conducted across six schools (three treatment, three control), in which artists/instructors taught	Cluster randomised trial drawing on mixed methods data (document analysis; observation in classrooms; locally-developed rubric; observation of PD sessions; focus groups; interviews; New York State ELA and math standardised	Schools (N=6, 3 assigned to the treatment (N=545 students; n=66 teachers; n=3 visual arts specialists; n=15 administrators), 3 assigned	Integration in this study is centred on arts integration, defined as follows: "'Arts integration" generally refers to various strategies to use arts activities to teach explicit skills and knowledge in other subject areas' (p.2). Explicit links were made between visual arts, English and math, while "maintaining the integrity, depth, and rigor of instruction in both	Findings are reported under two headings: 1) Implementation Study Findings: collaboration between teachers and artists/instructors was crucial - the authors state that it was important that the lessons were taught by practicing artists, but supported by knowledgeable teachers; curriculum units needed to be differentiated for each school, including significant differentiation for children with special educational needs; artists were more comfortable linking visual arts with	(i) Variation in dosage amongst treatment students/schools, (ii) limited information provided on fidelity of implementation;	Journal Article (Peer Reviewed)

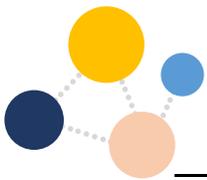




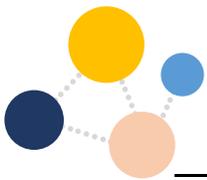
integrated lessons in classrooms with support from teachers. The study reports on academic and other outcomes.	test scores; rubric to assess artwork; NYC Visual Arts Benchmark Arts Assessment; Studio Habits of Mind rubric; surveys)	to the control (n=456 students; n=52 teachers; n=3 visual arts specialists; n=15 administrators)	subjects" (p.2). Learning units explicitly addressed the standards for each area. No other/specific integration model is adopted; the term 'interdisciplinary' is used.	literacy than with mathematics; busy school schedules posed a number of challenges - it was difficult to teach all curriculum unit lessons; curriculum change (CCSS) also posed difficulties; teachers reported that they had a new appreciation for arts integration but that they would not be able to teach these lessons without the support of a trained arts educator; qualitative data indicated improved student engagement and self-confidence
				2)Impact study findings: Multiple regression analyses held constant the standardised test scores from the preceding year, dosage, and demographic characteristics; they revealed that treatment group students made greater learning gains than those in the control group in both English Language Arts (ES=0.121 SDs; p<0.05) and maths (ES=0.240 SDs; p<0.001); repeated measure ANOVA revealed that students in the treatment group showed significantly greater growth in reflecting, $F(92, 274) = 7.550, p<0.01; ES=0.33$); there was no significant difference in Studio habits of Mind; Chi-square analyses of Benchmark Arts Assessments showed that control and treatment groups performed similarly but significantly larger portions of the treatment reached proficiency on seven VA skills (X2 range from 3.48 to 20.32; $df = 1; p<0.05$); Teachers reported broadly positively on the project and its impact on their knowledge of art in the curriculum;



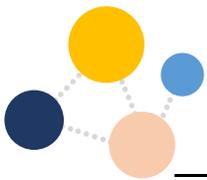
<p>da Silva-Branco (2021) Australia</p>	<p>This study examines the perceptions and experiences of teachers in the context of the cross-curricular priority of sustainability in the Australian curriculum.</p>	<p>Interviews (semi-structured interviews)</p>	<p>Teachers (including school administrators) (N=9)</p>	<p>Sustainability as a cross-curricular priority is the key integrative concept examined in this study. Other than referring to this curricular context, no specific model of integration is endorsed or used.</p>	<p>(i) teachers integrate sustainability across a range of disciplines, as envisaged by the curriculum; this happens in both planned and incidental ways; teacher account of sustainability practice tended to emphasise the environmental aspects more so than the social or economic; the authors conclude that particularly strong connections are made between sustainability and science concepts (ii) school leadership had an important role to play in embedding sustainability across the curriculum; some teachers felt that sustainability was supported when the school building itself was built in a sustainable way (e.g. use of underground water), thus providing greater exposure for students; whole-school initiatives supported the teaching of sustainability (e.g. kitchen garden program). Overall, the participants in this study did not appear to have difficulty in integrating sustainability, unlike the findings reported in other studies.</p>	<p>(i) Teachers self-selected and were already interested in sustainability and thus may not represent the general views of teachers, (ii) small sample size, (iii) reliance on self-report measures</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Dan (2018) China</p>	<p>The authors interviewed in-service teachers to examine their expectations regarding Professional Development for integrated STEM teaching in elementary schools. The authors also sought to identify the challenges or barriers experienced by teachers in accessing PD for STEM education.</p>	<p>Qualitative (Interviews)</p>	<p>In-Service Teachers (N=8)</p>	<p>No specific framework or model of STEM/Curricular Integration was advocated or discussed as part of this research.</p>	<p>Teachers identified the following challenges in accessing and maximising benefit from PD for STEM education: (1) How to apply PD content in classroom contexts, (2) Insufficient support from school leaders/PD providers, (3) Insufficient curricular guidance, (4) PD courses not differentiated to their individual needs.</p>	<p>(i) Limited data gathered, (ii) Sample may have been biased</p>	<p>Conference Proceedings/Papers</p>



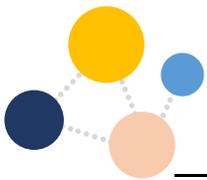
<p>Delahunty (2021) Ireland</p>	<p>The purpose of the study was to establish primary school teachers' perceptions of utilising an integrated STEM approach in their classrooms and the supports and challenges associated with the same. Teachers were enrolled in a practice orientated module on STEM education - this was a component of their own postgraduate studies.</p>	<p>Qualitative (Interviews)</p>	<p>In-Service Teachers (N=6)</p>	<p>Teachers were asked their views on the use of an integrated approach to STEM in general terms - no specific framework or model was advocated or discussed as part of this research.</p>	<p>Three key themes were constructed from the data gathered: (1) Perceptions of utilising an integrated approach, (2) Key Challenges, and (3) Supports. In relation to theme (1), teachers were positive on the benefits of using an integrated approach to STEM, citing the development of key skills like collaboration, problem solving among their learners as a key benefit. They did note that for certain disciplines (specifically engineering and technology) they would have concerns on their content knowledge. Regarding theme (2) key challenges that emerged included: lack of confidence/fear, lack of Professional Development (PD), insufficient clarity from curriculum documents, curriculum overload, parental concerns on project-based learning, time, and lack of resources. For theme (3), teachers identified the following supports for future STEM integration in Irish contexts: STEM curriculum (with emphasis on engineering/technology guidelines), curricular integration, long term planning exemplars, appropriate professional development [inadequacies of summer courses], university partnerships.</p>	<p>(i) Limited data gathered, (ii) Sample may have been biased</p>	<p>Journal Article (Peer Reviewed)</p>
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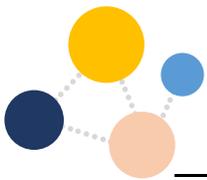
<p>DeLuca (2015) Canada</p>	<p>This study examines the experiences of students who partook in a 'curriculum clusters' approach to ITE, which integrates subject areas into one course/module that addresses 'content, themes', and assignments'. Student perceptions are contrasted with those studying the same subjects in discrete courses/modules.</p>	<p>No overall design-qualitative (survey, focus groups, interviews)</p>	<p>Pre-service teachers (N=56); Course instructors (N=3)</p>	<p>The authors rely on examples of how integration is conceptualised in Canadian curriculum documents, e.g. Alberta (see page 229). Their explication of the benefits of integration rely on scholars like Fogarty and Stoehr (1995) and Drake and Burns (2004; 2007). Both the terms 'inter' and 'trans' disciplinary are invoked but not fully defined. No clear conceptualisation of integration is offered; it is implied or presumed to be known by the reader.</p>	<p>Findings are arranged in eight themes: a) reflecting elementary teaching: integrated ITE courses better reflected the reality of teaching in an elementary school; b) building relationships: a sense of community was built by having one teacher across the subject areas; c) conception of integration: PSTs' conceptions and understanding of integration improved, including their ability to assess in an integrated way, to link with school placement; d) emphasis on pedagogy: through modelling of the instructor and linking pedagogy across multiple areas; e) teaching efficiency: PSTs were less likely to be overwhelmed due to integrated assignments; material was less likely to be duplicated across modules; f) perception of content coverage: some PSTs expressed concern that content was less clearly developed/learned in the clustered classes; g) perception of instructor expertise: PSTs felt they were disadvantaged in the clustered class because they did not have discipline experts delivering material</p>	<p>(i) Small sample, (ii) researchers involved in analysing their own ITE programme, (iii) lack of detail about core concepts (integration)</p>	<p>Journal Article (Peer Reviewed)</p>
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DePaola (2022) United States	This study examines perceptions of the impact of interdisciplinary teams at the middle school level; these teams involve collaboration between two or more teachers from different content areas (usually 'core' areas: science, maths, language arts, social studies).	Instrumental Case Study (interviews; focus groups; observation of team meetings; documentary analysis [e.g. agendas, student work, curriculum materials])	Middle school teachers (n=8) (7th/8th grade) were interviewed; n=18 participated in focus groups (inclusive of the 8 interviewees); all came from the same school (which had been designated a 'school-to-watch' in 2019)	Integration in this study is focused on interdisciplinary connections between different subjects in the middle school curriculum, delivered by interdisciplinary teams. These subject specialists have common planning time and work with a common group of students, allowing integration to occur. Merenbloom (1996) is cited to explain interdisciplinary learning in this context.	(i) Common planning time was structured in a manner that support collaboration across disciplines/teachers, though scheduling was a challenge; teachers felt a better sense of efficacy due to the feeling of belonging inculcated by team membership, (ii) Distributive leadership, shared decision-making and trust were identified as important factors in school success, (iii) Collaboration amongst teacher was important in identifying interdisciplinary skills across subjects; flexibility was needed in planning these interdisciplinary units, with some teachers noting forced connections at times; meetings between teachers supported their development of knowledge and PD across disciplines; teachers reported seeing benefits in student learning from interdisciplinary work (e.g. better support; better sense of belonging), (iv) Trust and respect was required to support positive group dynamics on a team; team leaders supported the distribution of leadership	(i) Small sample size, (ii) no learner outcome data reported, (iii) the role of the researcher as a supervisor in the same district may have influenced teacher reports, (iv) reliance on self-report from teachers, (v) short time span of study	Doctoral Thesis
Dogan (2019) Turkey	This study examined the impact of an interdisciplinary approach to the teaching of fractions to 1st Grade learners.	Case Study (Observations; Interviews)	1st Grade Learners (N=40)	The authors use the term 'inter-disciplinary' to describe integrated teaching. They rely heavily on Yildirim's (1996) work to describe inter-disciplinary teaching approaches stating that it involves the presentations of "traditional subject areas in a meaningful way around certain concepts".	The learners appeared to have a good understanding on the relevance of fractions to their everyday life as well as a strong understanding of key conceptual issues e.g., quarters means '4 parts'. Students appeared to enjoy the interdisciplinary approach.	(i) Analysis of the observational data required more rigour, (ii) role of the researcher in the study is somewhat unclear (potential for researcher bias), (iii)measures of academic outcomes were needed for some of the conclusions drawn	Journal Article (Peer Reviewed)

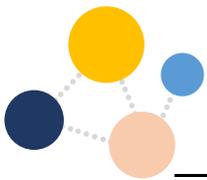


Dowden (2014) Australia	Teachers from two schools in Tasmania provided their thoughts/perceptions on curriculum integration via questionnaire and interview responses. The researcher concluded that focussing on subjects rather than students as the fulcrum for integration is problematic.	Qualitative akin to a case study (interviews/questionnaires)	Questionnaires (N=30) and interviews (n=4) from teachers in two middle schools in Tasmania.	Integration is defined by the author as "A collective term for curricula where meaningful learning activities are designed by crossing discipline boundaries and/or utilising multiple disciplinary perspectives with the purpose of helping students to create and enhance knowledge and understanding."	Teachers reported a focus on subject-centred integration rather than student-centred integration	(i) Small in scope, (ii) results from empirical data are not reported in depth- more attention afforded to the findings/thoughts from the literature review	Journal Article (Peer Reviewed)
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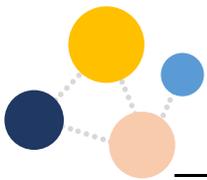


<p>Doyle (2014) United States</p>	<p>This paper briefly summarises the results of the first two years of a three-year professional development programme that supports teachers with arts-integrated approaches to teaching and learning. A range of data was gathered to evaluate the programme including teacher interviews and student standardised assessment data (English Language Arts).</p>	<p>Quasi-Experimental (Mixed-Methods, Multi-Site design with pre-post data collection; researcher-designed measure of teachers' understanding of arts standards, teacher interviews, observations, artefacts [training documents], and student scores on standardised tests of language arts)</p>	<p>Teacher Interviews: (N=17), Teacher Survey/Knowledge Tests (Pre & Post): (n=34), Student Test Scores across 6 schools (3 of whom were involved in the intervention)</p>	<p>The authors acknowledge the range of definitions associated with arts-integration but note that they have key 'themes' that unify them i.e. interdisciplinary, cross-curricular, process-oriented approaches, with most suggesting a collaborative relationship between classroom teachers and arts specialists. They do highlight the value of the Kennedy Center's definition but note that work by Goldberg (2012) and Burnaford et al. (2007) are also useful in distinguishing between key elements of arts-integration. Goldberg (2012) adds to the field's understanding by distinguishing between two facets of the arts integration paradigm: learning with the arts and learning through the arts. Burnaford et. al. (2007) discuss three dimensions of arts integration: transference, connection making and collaboration.</p>	<p>Regarding teacher knowledge on arts and arts-integration, there was statistically significant growth in both years and continued growth from year 1 to year 2 despite more stringent scoring in year 2; $t(33) = 3.66, p < .001$. Teachers also appeared to be aware of their professional growth. In interviews, teachers noted students' enjoyment of arts activities and eagerness to have the artists present in their classrooms. Student benchmark testing results in the first year were mixed. At the sixth grade level, CoTA students showed significantly lower gains than did comparison (partial $\eta^2 = .035$). While at the second and third grade levels, CoTA students showed significantly greater gains on the tests (partial $\eta^2 = .061$, partial $\eta^2 = .017$). For Year 2, an ANCOVA found that there was no statistically significant difference between CoTA and comparison student growth in grades 3, 4, or 6. However, once the covariate Q1 scores were accounted for, there was a statistically significant difference between CoTA and comparison students' scores in second [F (1, 319) = 11.47, $p < .01$] and fifth grade [F (1, 319) = 9.674, $p < .01$], with higher CoTA adjusted means.</p>	<p>(i) study described outcomes at the end of Year 2 (rather than Year 3), (ii) the analysis applied for both qual and quant data needed a more detailed description i.e. it appears that the comparison and treatment schools may have been significantly different in terms of student functioning (CoTA explained between 2% and 6% of the variance, while intervention-comparison differences on the pre-test accounted for about 50% of the variance), (iii) intact groups, (iv) generalisability (i.e. intensive PD programme)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Duggan (2021) South Africa</p>	<p>This study explored how integrated curriculum units could improve environmental education in rural coastal communities in South Africa.</p>	<p>No overall method stated, but ethnographic approaches are invoked (participant observation/ interviews, group discussions, feedback sessions)</p>	<p>Schools in rural/coastal South Africa (N=2); students/teachers in grades 7-9 (precise numbers not provided)</p>	<p>The authors are critical of the curriculum in place in South African schools, stating that it aligns with the 'fragmented' model outlined by Fogarty (1991). The authors set about enacting a 'sequenced' model of integrated curriculum (Fogarty, 1991)</p>	<p>The integrated modules were successfully implemented; students enjoyed integrating multiple modes/media; linking the learning with the local area ('a situated approach') proved fruitful; relating lessons to the local context and environment was deemed important; the researchers perceived benefits that stretched beyond the school, with parents/residents reporting learning from the project</p>	<p>(i) One of the schools did not enact the integrated materials due to local circumstances, (ii) highly specific contextual factors that will not generalise, (iii) lack of outcome data, (iv) limited information provided on data analysis, (v) some limited information on participants</p>	<p>Journal Article (Peer Reviewed)</p>



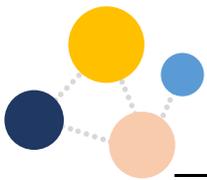


<p>Duke (2021) United States</p>	<p>Pairs of teachers in each school were randomly assigned to either the treatment group or the comparison group (which involved teaching their regular, non-project-based social studies curriculum); baseline equivalence was confirmed. Teachers in the experimental group taught four integrated social studies/literacy units addressing economics, geography, history and civics/government.</p>	<p>Cluster randomised controlled trial (social studies assessment [researcher designed]; informational reading assessment [researcher designed]; informational writing assessment [researcher designed]; motivation survey for social studies, literacy learning, integrated social studies and literacy [based on other available surveys, but researcher-designed]; structured observations; interviews)</p>	<p>Second grade teachers (N=48) and their students (N=684, n=289 in comparison group, n=395 in experimental group) from 20 low SES elementary schools</p>	<p>Models of curriculum integration are not explicitly addressed in the framing of this study. The study is based on the tenets of high quality project-based learning, which in this instance include the integration of literacy with social studies units.</p>	<p>Using hierarchical linear modelling to control for gender, race/ethnicity, mother's level of education and baseline scores, the experimental group scored higher on social studies knowledge (ES = 0.482, $p < .001$, two-tailed) and informational reading (ES = 0.182, $p = .083$). There was no significant difference for informational writing or motivation measures. Teachers that enacted the units with higher measures of fidelity with improved scores on all measures: social studies (ES = 0.270, $p = .301$), reading (ES = 0.583, $p = .030$), writing (ES = 0.239, $p = .065$), and motivation (ES = 0.287, $p = .016$)</p>	<p>(i) Use of researcher-developed assessment instruments, (ii) overall sampling of schools was not random (convenience), (iii) high level of instructional support not replicated easily, (iv) limited qualitative/experiential data reported in this study</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Dyment (2014) Australia</p>	<p>Drawing on survey results, this study examined teachers' self-reported knowledge of sustainability and the manner in which it is taught in a cross-curricular priority in Tasmanian schools.</p>	<p>Instrumental Case Study (online survey)</p>	<p>Principals/curriculum leaders from Tasmanian schools (N=68)</p>	<p>The term 'cross-curricular' is given precedence in this study as it focuses on the cross-curriculum priority of sustainability in the Australian curriculum. The term 'interdisciplinary' is also used, with reference to authors like Barnes (2011). Feng (2012) is also cited in explaining why interdisciplinary is important for sustainability, given its complexity.</p>	<p>Teachers' self-reported understanding of sustainability was better when considered more broadly than when considered in the context of very specific aspects of sustainability; when asked to pick five words to represent sustainability, the largest proportion (54.4%) related to the theme of the environment/natural (e.g. words like 'recycling'); the cross-curriculum priority was most likely to be integrated into science, followed by RE, with the lowest likelihood of integration appearing for economics and languages.</p> <p>In the discussion, the authors conclude that school leaders have limited understanding of sustainability, meaning it is unlikely that they can integrate it successfully into cross-curricular teaching. Nonetheless, they highlight promising 'emerging possibilities for interdisciplinarity' in some of the examples cited by teachers (e.g., use of school gardens).</p>	<p>(i) Reliance on self-report data, (ii) authors identify potential for sampling bias - most interested/active schools may have participated, (iii) limited focus on learner outcomes</p>	<p>Journal Article (Peer Reviewed)</p>



Dyment (2015) Australia	<p>This study examines PSTs' knowledge of sustainability, in the context of the Australian national curriculum (which sets it as a cross-curricular priority). Survey results from 392 PSTs are used to tease out the challenge of teaching sustainability in this manner.</p>	<p>Instrumental case study (questionnaire)</p>	<p>Pre-service teachers (N=392)</p>	<p>In the latter portion of the paper, the authors refer to the work of Beane and Barnes but also note the risk of the 'seductive' charms of a cross-curricular approach (citing Hayes, 2010)</p>	<p>PSTs' self-reported knowledge of sustainability was higher for the general concept than it was for more specific aspects of sustainability. Though they reported somewhat low learning opportunities for learning about sustainability as a cross-curricular priority, they nonetheless felt that it was important (and that they were willing to implement it). Analysis of the five words that each PSTs chose to describe sustainability revealed that 59.2% related to the environmental/natural dimension of sustainability (e.g. recycling). In the conclusion, the authors are critical of the lack of support offered to PSTs in their ITE programmes.</p>	<p>(i) Reliance on self-report</p>	<p>Journal Article (Peer Reviewed)</p>
Edsall (2012) United States	<p>A diverse 5th grade class worked with a state funded programme to create a teacher guided opera based on the American Revolution. This process was guided by two teaching artists. Data collected for this qualitative study included interviews with students and teachers, surveys, and six months of weekly classroom observations.</p>	<p>Qualitative (Researcher Designed Observation Tool; Surveys (with students); Interviews with teachers, artists; Focus groups (with students))</p>	<p>In-service teacher (N=1) collaborating with Teaching Artists (N=2); students (N=14)</p>	<p>The author provides a brief overview on the history and theoretical foundations of arts integration. While it is not directly stated, this study's approach to integration appears to align with Aprill's (2010). This definition states that arts integration 'is teaching and learning in which arts learning and other academic learning are connected in ways in which the arts learning and the other academic learning are both deepened' (Aprill, 2010, p. 7).</p>	<p>The students involved deemed this unit of work 'valuable' and enjoyable, partially due to the active teaching methods deployed. Interviews conducted with teachers/artists revealed what they perceived to be the impact of the arts-integrated programme on students' overall learning and academic success. These participants highlighted that, in their opinion, students' skills regarding critical thinking, verbal expression, teamwork and project management were positively impacted by their involvement in this arts integrated programme (Key Theme 1: Enjoyment of the process, Key Theme 1: Cross-curricular activities, and Key Theme 3: Learning students apply outside the curriculum). Regarding the role of learner voice in this study, the students identified a number of ways in which they believed student voice could be better facilitated e.g., increased emphasis on listening to student suggestions before making a particular decision.</p>	<p>(i) poor definition of CI, (ii) inadequate consideration of potential confounding factors, (iii) inadequate outcome measures</p>	<p>Doctoral Thesis</p>





Edwards (2016) Australia	This study examined how early childhood educators leverage students pop culture interests to teach about environmental topics and well-being, with a particular focus on food products (e.g. packaging and waste; healthy eating).	Part of a larger randomised trial. No specific design for this study. (Analysis of educators' planning documents)	Early childhood educators (N=6) and the children in their kindergartens (N=128)	Integration is not conceptualised in this study.	Educators planned learning experiences that drew on student interests in a number of ways. Educators established their food product interests (e.g., fast food outlets; pop culture characters) through discussion, observation and questioning and subsequently used these interests to teach about wellbeing (e.g. how many spoons of sugar are in a given food) and environmental topics (how much packaging was in a given food). The authors conclude that this approach can be successful in integrating wellbeing and environmental education.	(i) No observation data - relies on self-report of teachers, (ii) no child outcomes measured	Journal Article (Peer Reviewed)
Eli (2020) Norway	The Norwegian core curriculum for sustainable development calls for interdisciplinary teaching. The Sustainable Backpack Program (SBP) targets sustainable development in primary, secondary and upper secondary schools. This study examines how teachers planned interdisciplinary units to support student learning in sustainable development, with a particular focus on the subjects/disciplines integrated.	Multiple case study (content analysis of curriculum units developed by teachers)	Schools (N=14)	The authors view interdisciplinary teaching as "integration and interaction of subjects involved in solving a shared problem" (p.797). They further state: "Teachers from different subjects have to coordinate and collaborate in this problem-solving process in their teaching. While multidisciplinary approaches draw on knowledge from various disciplines that remain within their boundaries, interdisciplinarity analyses synthesise and harmonise the interrelated disciplines into a coordinated and coherent whole."	The curriculum units drew on varying disciplines. All units included natural science (a requirement of participation); 71% included social studies; 57% of units included the Norwegian language subject; 64% included mathematics; 29% included art and crafts; 36% included PE. The authors describe the specific competence aims (akin to standards/curriculum outcomes) that were addressed in each. They point out that the economic aspects of sustainable development receive poor attention in the integrated units and they also note that there is untapped potential for interdisciplinary learning in the Norwegian language (e.g. argumentation) and CRPE (Christianity, religion, philosophy of life and ethics).	(i) Reliance on documents - no observation/outcome measures, (ii) no comparison with teachers who did not attend PD	Journal Article (Peer Reviewed)
Ensign (2012) United States	This study examined the impact of a four-hour professional development workshop involving educational robotics (ER) with elementary school teachers. This research investigated the impact of such an intervention on educators' attitudes about their ability to teach ER (ability), the value (utility) of the technology, and their desire to use it (intent). Pre-post survey data was collected. Further data was	Intervention [Pre/Post with no control] (Surveys [modified version of Science Teaching Efficacy Belief Instrument], Interviews)	In-Service Teachers (n=100 [pre-post data], n=33 [post-post data], n=21 [21])	The authors offer this definition of STEM: 'STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons' (p. 13). No other discussion on the integration of these disciplines is provided. The author does discuss the value of the TPACK (Technological Pedagogical Content Knowledge) model in supporting	Results comparing the pre- and post-workshop means determined that there were statistically significant differences with large effect sizes in educators' attitudes across the subscales of ability (eta-squared=.50), utility (eta-squared=.23) and intent (eta-squared=.16). The interview data supported the conclusion that participation in the workshop and access to classroom kits are important for successful implementation of ER in classrooms. Post-post data did not reveal	(i) commercial kits used in the intervention, (ii) short duration of intervention, (iii) selection bias, (iv) researcher bias	Doctoral Thesis

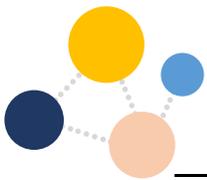


gathered after educators had an opportunity to use robotics with students (post-post).

the design of professional development programmes that wish to support teachers' use of technology (like ER).

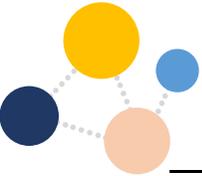
a statistically significant differences in educators' attitudes, demonstrating persistence of attitudes consistent with the interview results that revealed educators value the "hands-on" nature of ER which they believe increases student engagement in STEM and cross-curricular learning. Their experiences in the workshops were also enjoyable and empowering.

Evans (2015) United States	This study examined elementary pre-service teachers' perceptions, attitudes, confidence, and abilities to integrate STEM into their instruction. The study took place across two semesters where the pre-service teachers were exposed to modules on STEM education and curriculum integration, culminating with a week-long, STEM-integration teaching experience at a local elementary partner school Data was gathered pre-, mid- and post-intervention.	Mixed-methods study (Interviews; Surveys [STEM Semantics Survey, Science Teaching Efficacy Beliefs Instrument (STEBI-B)]; Rubric for analysing Lesson Plan quality)	Pre-Service Teachers (N=12)	The author devotes some time to the discussion of curricular integration and offers this definition based on their engagement with the literature: 'curriculum integration is defined, collectively, as an educational approach where students study an integrated or interdisciplinary theme or topic and its related issues in the context of multiple disciplines' (p. 26). The model of integration chosen for this study was Bybee's (2013) embedded model of curricular integration can be considered a 'beginner' model of curricular integration appropriate for pre-service teachers (whereby pre-service teachers focus on one subject i.e. Science and then make connections to other curricular areas where appropriate).	Analysis of the survey data indicated that the pre-service teachers' perceptions, confidence, and abilities were positively impacted by the STEM-based preparation modules that they received from their programme of Initial Teacher Education (not all of these improvements were statistically significant however). Qualitative findings supported the quantitative results and further emphasised the positive trend in elementary pre-service teachers' attitudes toward STEM as a result of engaging in STEM-based preparation	(i) quantitative data is difficult to generalise due to small sample size, (ii) specific details on the pedagogies etc. recommended to the pre-service teachers was missing (iii) Very constrained sample (one university course) (iv) researcher was involved in the assessment of their own students	Doctoral Thesis
Fazio (2018) Canada	Researchers worked with four elementary teachers to develop a unit that integrated science and literacy. The researchers documented key learning from this process, which was grounded in design-based research principles.	Design-based research (interviews, field notes; recordings of DBR meetings/sessions)	Elementary teachers (fifth grade) (N=4)	Science and literacy were integrated in an instructional unit on 'Properties and Changes in Matter'; there is a dearth of information on the precise pedagogical approaches used	(i) effective collaboration between teachers and university partners in the collaboration supports integrative teaching, (ii) the DBR partnership improved teachers' ability to integrate science and literacy in more complex ways, (iii) teachers were slow to embed technology in their integrative practice	(i) Very limited information on student learning outcomes/progress, (ii) non-specific information on the pedagogical foci enhanced/developed through the DBR cycles, (iii) small sample size	Journal Article (Peer Reviewed)

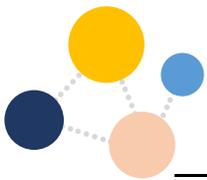


<p>Fazio (2019) Canada</p>	<p>This study tracked how integrated science and literacy teaching would impact on student scores on vocabulary, comprehension and science content. Five teachers and the children in their classrooms participated.</p>	<p>Mixed methods design-based research (QUAL: interviews; meeting recordings; fieldnotes; observations; QUAN: standardised measures of vocabulary, comprehension [Canadian Achievement Test]; researcher designed content assessment of science)</p>	<p>Fifth grade teachers (N=5) and students from their classrooms (N=118)</p>	<p>Science and language were integrated; models of science and language integration are invoked (e.g. Cervetti et al., 2012)</p>	<p>Student growth in vocabulary, comprehension and science is reported on a class by class basis; in all but one classroom there were significant changes on most measures, with medium to large effect sizes. When classes were analysed in aggregate, there was an effect size of $d=0.78$ for science, $d=0.51$ for vocabulary and $d=0.33$ for comprehension. The researchers concluded that variation in how integration was enacted accounted for variation in results from classroom to classroom, e.g. the non-significant improvement in scores in one classroom was attributed to the teachers' low confidence levels in science.</p>	<p>(i) This study would have benefited from more sophisticated statistical analyses of nested/grouped data from across the two schools and five classrooms (linear modelling)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Feldwisch (2014) United States</p>	<p>This research examines the enactment of the Arts Integration Program (AIP) in 11 schools. This programme was developed by an unnamed national non-profit, who solicited the researchers/authors to examine the implementation of the programme.</p>	<p>Intervention - pre/post no control, mixed methods (observations, interviews, pre/post literacy assessment [SLAT - a tool used specifically on this project])</p>	<p>Schools (N=11): observations in 51 classrooms; interviews with teachers (n=30); SLAT scores from students in year 2 (n=43) and students in year 3 (n=190)</p>	<p>This study is broadly underpinned by the literature on arts integration. Specific models of curriculum integration are not cited.</p>	<p>(i) Students were described as being highly engaged in arts integrated lessons, demonstrated in eye contact, avoidance of off-topic talk, behavioural indications of excitement (e.g. smiles); teachers indicated that students were highly enthusiastic about the lessons; during artist residencies, student engagement was even more pronounced; high levels of collaboration typified the instruction; teachers indicated that students had extended opportunities for self-expressions during these lessons, (ii) Quantitative findings (SLAT- Literacy): test scores improved from the start to the end of the year in each of the years 2009/2010 (year 2 of the study) and 2010/2011 (year 3 of the study), however these differences were only significant in the first year, (iii) Student perspective: A number of challenges were reported, which varied by grade level: e.g. students grew frustrated when asked to revise their work; the SLAT assessment was complex and time-consuming, (iv) Teacher perspective: Teachers generally 'bought in' to the AIP units; researchers indicate that -based on self-report- teachers implemented the programme with fidelity; teachers collaborated well with other</p>	<p>(i) Limited information on the nature of field notes taking during observations, (ii) limitations in the nature of the quantitative data collected - not all students provided consent (potential for sampling bias), variation in numbers from year to year;</p>	<p>Journal Article (Peer Reviewed)</p>



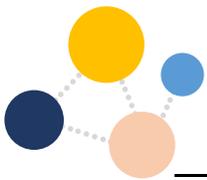


					specialist teachers (e.g. art, music); a high level of support was received from administration/parents; teachers transferred learning from AIP into other lessons; challenges included some teachers feeling out of their comfort zone, instructional materials being too difficult for some grade levels, requiring more time to implement the units and implementation of the SLAT assessment.		
Ferguson-Patrick (2016) Australia	This study explored the challenges and opportunities involved with teaching an integrated curriculum and considers this in relation to the ideas associated with '21st century curriculum' and pedagogy. This was done by examining curriculum documents and pre-service teachers' experiences in schools during professional placement. This was examined through the lens of 'Global Education'	Mixed Methods (Researcher-Designed survey, Document Analysis [Policies, Curriculum Statements from districts including the US, UK and Australia])	Pre-Service Teachers (N=187; 86 were undergraduate students who had just completed their first professional placement; and 101 were a mixture of undergraduate and postgraduate students after a course focus on multilevel pedagogies and integrated curriculum)	The authors offer a comprehensive overview of CI and identify three key reasons to explain why there has not been any consensus regarding its efficacy (range of operational definitions, lack of empirical data, unclear expectations). The authors do not offer their own definitions of IC in this paper.	Regarding the role of curricular integration in policy documents, the authors noted that it is not explicitly stated in many key documents in Australia and in other districts. The 'need' for Global Education is evident in some documents but there are few guidelines on how this can be achieved. Regarding teachers' experiences on professional placement, the GE strategies they observed included: anti-bullying and conflict resolution strategies; classroom management and organisation; cultures and celebrations; environments and sustainability; immigration and refugees; international connections; Olympics (Olympic year); and technology use.	(i) sampling issues (e.g. reporting of sample made it difficult to determine the number or pre/in-service teachers involved etc.), (ii) limited range of data	Journal Article (Peer Reviewed)

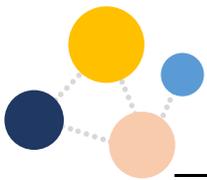


Fitzpatrick (2018) Ireland	This study examines how a Negotiated Integrated Curriculum was carried out in two primary classrooms in Limerick. The NIC involved students in a high degree of decision-making in what they would learn, supported by the researcher and classroom teacher. Qualitative data inform the analysis of the project.	No overall design stated - qualitative (focus group, video/audio recordings, researcher journal, interviews, student reflections)	Primary schools (N=2); 23 5th and 6th class children in school 1, 28 4th class children in school 2	This study focuses on a 'negotiated integrated curriculum' (NIC), which draws on principles of curriculum integration (citing authors like Fogarty [1991], Beane [1993]) and student agency/engagement. NIC is defined as follows: "a form of thematically linked curriculum. Its central and distinctive features are a theme based on students' expressed concerns in relation to themselves and global issues; continuous negotiation with students about their questions, learning activities and their appropriate assessment methods to address these concerns; and the integration of traditionally discrete subject boundaries." (p.459)	(i) Student voice: the level of student participation in setting learning content was atypical when compared to normal school experience; this was evidenced in both teacher and student data, (ii) Student decision-making: students needed scaffolding to decide on appropriate assessment strategies for their learning, with one teacher commenting that a written test would have been more straightforward; a certain amount of 'non-negotiables' were set out by teachers, such as time constraints; these non-negotiables included content that *had* to be taught in order to 'cover' the regular curriculum', (iii) Responsibility and autonomy: Students gradually came to rely less on the teacher; students were successful in planning out full days of learning (e.g. in a PE day), (iv) Meaningful learning: Student ownership over their own learning/researcher led to heightened engagement, (v) Trust: Power relationships needed to be re-tuned throughout the collaboration so that students could trust the process; teachers initially found it challenging to have student take control; teachers had to follow through on promises to allow students to direct their own learning	(i) Limited information provided on exactly how curriculum integration was undertaken (e.g., subjects/disciplines engaged), (ii) small scale study, (iii) outcome measures not gathered, (iv) potential for researcher effects/social desirability not teased out in findings	Journal Article (Peer Reviewed)
Follong (2020) Australia	This study drew on survey methods to investigate how Australian teachers integrate mathematics teaching with nutrition related activities (e.g. measuring volume).	Survey (researcher-designed questionnaire)	Australian teachers of year 3 or year 4 (N=101)	Beckmann's (2009) framework for cross-curricular teaching is cited; this focuses on cross-curricular mathematics teaching.	Survey results showed that nutrition-related examples were used to explain/demonstrate volume/capacity in mathematics lessons (e.g. cooking/recipes, household measures), but that smartboards and cube/blocks were the most common resources for this aspect of the curriculum. Over half of teachers did not use digital games to teach capacity, but many reported that they might use them in the future were they available. When asked about cross-curricular teaching, most teachers were most likely to integrate mathematics with English and science.	(i) Reliance on self-report, (ii) constrained focus of the questionnaire, (iii) potentially leading questions	Journal Article (Peer Reviewed)

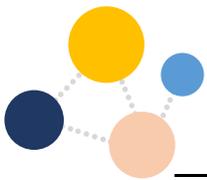




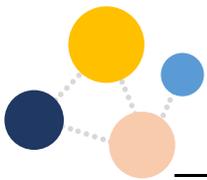
<p>Follong (2022) Australia</p>	<p>This paper reports qualitative findings from a broader quantitative RCT on portion size. As part of this intervention, teaching on portion sizes was integrated into the mathematics and Personal development, Health and Physical Education curriculum.</p>	<p>Qualitative (semi-structured interviews; focus groups); part of a broader mixed methods study</p>	<p>Year 3/4 teachers (N=3); Year 3/4 students (N=15)</p>	<p>This study focuses on how nutrition can be integrated into the mathematics curriculum; it does not have a strong conceptual framing in the integration literature.</p>	<p>Findings from teachers are reported under five themes: (i) Lesson content: Teachers welcomed the lesson content (integrating portion size lessons) but indicated that they lacked depth so could not fully replace their teaching on volume and capacity; however, the lessons did address other aspects of mathematics also (e.g. problem solving, operations), (ii) Resources and materials: Teachers valued having the 'ready-to-go' materials, including thorough lesson plans, (iii) Student learning and achievement: Teachers indicated that students had better understanding of healthy portion sizes, (iv) Teaching experience: Teachers enjoyed teaching the lessons and would like to continue an integrative approach, (v) Programme benefits and challenges: A major benefit was being able to teach students about nutrition, but they also encountered challenges, e.g. limited resources and their ability to differentiate. Findings from students are reported under three themes: (i) Programme enjoyment: Students generally enjoyed the lessons, (ii) Resources and materials: nearly all students enjoyed the food models used, (iii) Student learning and achievement: Students could indicate that the programme was about nutrition in focus groups; majority of students felt that using real-life contexts was beneficial; all students felt they knew more about nutrition</p>	<p>(i) Potential researcher effects in reporting of qualitative data (socially desirable answers), (ii) small sample size</p>	<p>Journal Article (Peer Reviewed)</p>
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<p>Fragakis (2019) United States</p>	<p>This exploratory qualitative case study examined the perceived impact of an arts-integrated curriculum (within the areas of Maths and Social Studies) on the academic achievement of 5th/6th grade students with disabilities. After creating arts-integrated lessons, the teachers assessed student understanding of content using researcher designed rubrics. Students also self-assessed their own learning. Interview data was gathered to record participants' perspectives on arts integration.</p>	<p>Case Study (Interviews, Work Samples)</p>	<p>In-Service Teachers (n=N; classroom & SET), 5th/6th Grade Students (N=7)</p>	<p>The author states that ' arts-integrated curriculum, the focus is on the entire artistic process as it takes place throughout a lesson or a unit' (p. 18). Based on the work of Burnaford et al. (2007), the author also states that 'an equal relationship between the arts and the content areas is a significant aspect of arts-enhanced curricula'.</p>	<p>The author constructed three themes to summarise their findings. According to the author, an arts-integrated curriculum assisted with content area understanding (Theme 1), positively impacts student confidence (Theme 2), and affords students with disabilities a range of learning opportunities and ways to illustrate their understanding (Theme 3).</p>	<p>(i) Limited range of data collected - difficult to tell the actual impact of the arts-integrated curriculum on learning, (ii) Setting/Sample may have been biased, (iii) Conceptualisation of arts-integrated curricula was somewhat unclear</p>	<p>Doctoral Thesis</p>
<p>Frankel (2015) United States</p>	<p>This study draws on a large-scale data set to examine the impact of a writing-visual integrated programme, implemented 2-3 times a week by teachers in the middle elementary grades. 'Picture writing/image-making' involves students in hands-on artwork which feeds into their subsequent writing. The programme addresses both art and literacy state standards.</p>	<p>Quasi-experiment with matched comparison schools (pre/post art and writing samples scored using an instrument from previous research in this area; state reading and writing assessments(NECAP); Gates-MacGinitie Reading Comprehension test; district-level writing scores)</p>	<p>(n=1500) students per year (average per year); (n=77) teachers (average per year); three years of roll-out with teacher/student numbers varying slightly each year</p>	<p>Students integrate art with their literacy instruction; in 'picture writing' students are taught the language of art in creating pictures, drawing on the work of mentor texts and professional artists/writers; they follow up by writing about the pictures they have created; much of this writing is based on content from the science/social studies curriculum; in 'image-making' the focus is on collage and the use of 'cut and torn shapes' to visually and orally rehearse stories before writing them. These forms of teaching are facilitated within 'artists/writers' workshop'. No model of curriculum integration is cited.</p>	<p>(i) In each year of the study, students in the treatment condition made significantly larger gains in both writing/visual literacy scores when compared to the treatment group (large differences are noted, but no effect sizes are reported); gains were seen across demographics (e.g. special ed, ELL, across gender) (ii) A higher proportion of treatment group students reached proficiency in the grade 5 NECAP writing test, (iii) students scored significantly higher in most aspects of the district writing prompt assessment (e.g. voice), when compared to comparison schools (iv) Slight gains were seen in the state reading results (NECAP), with gains in on only year of the Gates-MacGinitie Reading test data</p>	<p>(i) some test items scored by teachers, others by independent researchers, (ii) distinctions are drawn between some treatment schools, with better results seen in one 'high fidelity' school, (iii) there was high staff turnover during the course of the study, (iv) lack of qualitative data to unpack the processes/challenges</p>	<p>Reports</p>

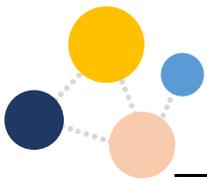


<p>Fu (2017) United States</p>	<p>This study surveyed teachers to identify their perceptions of curriculum integration; it focused on the forms of integration they adopt, how frequently they do so, factors that influence integration, and their perceptions around the effectiveness of integration.</p>	<p>Survey (researcher-designed questionnaire)</p>	<p>K-3 teachers from Ohio (N=42)</p>	<p>The authors adopt a 'broad definition' of integrated curriculum ("a collective term for any curriculum form that deliberately links knowledge associated with more than one subject area") and specifically focus on Jacobs' (1989) model.</p>	<p>(i) The vast majority of teachers had implemented some form of integration in their classrooms at some point, but there was variation in how often they did so (38.1% always did so, 26.2% frequently did so, 35.8% did so seldom/occasionally or never); complementary and paralleled discipline units were the most common form of integration (which the authors point out are the *least* integrated, according to Jacobs' model), (ii) teachers overwhelmingly believed that curriculum integration was effective, most felt they were competent to implement it, (iii) teachers' planning time and compatible working hours with colleagues were significant predictors of how frequently integrated curriculum was implemented (regression analysis; these factors accounted for 69.6% of variance)</p>	<p>(i) Reliance on self-report data, (ii) small sample for a survey-based study, (iii) qualitative data would better flesh out the findings</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Gallagher (2019) Canada</p>	<p>In this paper, the authors reflect on learnings from a design-based research project that sought to integrate literacy and science instruction. The authors draw on qualitative data from two years of DBR to point out the challenges and benefits of using this method as a professional tool/process to support integrated teaching.</p>	<p>DBR (researcher debriefings; journal entries)</p>	<p>Academics/ Design-based researchers (N=2)</p>	<p>The practical work that underpinned this study focused on the integration of science and literacy</p>	<p>Three themes are reported: i) The surface layer: teachers' planning and assessment practices; this focused on the need to support participating teachers with planning scaffolds for integrating science/literacy, using assessment data to inform planning, and the influence of instructional resources on teachers' thinking about integration; ii) Gritting teeth: Misunderstanding integration and disciplinary-based literacy; this focused on moving beyond superficial understandings of integration with teachers; iii) Getting to the bottom layer: 'Doing' DBR; DBR was not a straightforward process - it required negotiating of roles and responsibilities (e.g. researchers not over-directing the project but expressing frustration when teachers did not direct their own learning); it took time to develop rapport with teachers</p>	<p>(i) This paper reports only some findings from the overall study, (ii) it relies on a small sample</p>	<p>Journal Article (Peer Reviewed)</p>

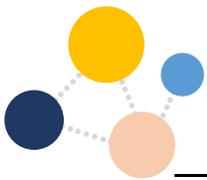


<p>García-Carrillo (2021) Spain</p>	<p>This study examined the experiences of two Spanish teachers before and after their participation in a professional development programme involving educational coding and robotics.</p>	<p>Case Study (Pre-Post Interviews, Observations)</p>	<p>In-Service Teachers (N=2)</p>	<p>The authors noted that STEM involves the integration of the four key disciplines through 'investigation and innovation'. No particular model of STEM is discussed or described. The term 'interdisciplinary' is used throughout the paper.</p>	<p>The results revealed the positive perspectives that the teachers held toward the STEM-integrated approach and educational coding and robotics, despite the difficulties that arose in classroom practice. The PD programme was successful in improving their understanding of either conceptual or pedagogical issues. It was concluded that the STEM approach and its methods were beneficial both to pupils and to teachers alike for improving the teaching-learning process (e.g., enjoyment, motivation etc.).</p>	<p>(i) small sample size, (ii) sampling bias (i.e. teachers already had an interest in STEM), (iii) researcher designed materials</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Gomez Zwiep (2016) United States</p>	<p>This study examined in-service teachers' initial conceptions of an integrated Project Based Learning (PBL) approach to STEM instruction and their perceptions of what facilitates or hinders implementation in their schools. Data was gathered from a STEM Professional Development Programme (involving a week-long summer institute and a cross-curricular planning unit) for middle school math, science and English language arts teachers.</p>	<p>Qualitative (Daily institute reflections, final institute evaluations, lesson study reflections, institute artefacts, teacher interviews)</p>	<p>In-Service Teachers (N=75)</p>	<p>No strong conceptual framework arising from the literature on curricular integration is present in this study.</p>	<p>Theme 1: Teacher Identity (Teachers reported feeling overwhelmed with new standards [particularly in their 'non-subject' area] but they did appreciate the 'interconnectedness' of the subjects addressed within the PD programme and its value for their learners. Authors noted that a lack of comfort with content was often a barrier for the non-STEM teachers.) Theme 2: Teaching Practice (Teachers found that focussing on the 'big ideas' to create a 'conceptual flow' was an easier way to connect the curriculum i.e. 'starting from content'. Teachers also acknowledged that it was difficult to 'let go' of control and engage in a more 'constructivist philosophy of teaching'. The authors noted that such a shift took time i.e. > 1 year of PD). Theme 3: Role of Institutional & School Structures (District and school level support was seen as essential for STEM-PBL work, particularly in relation to scheduling). Theme 4: Resource Needs (Authors noted that the teachers valued collaborative planning. The PD experience was also a valuable resource to teachers as it afforded them a learning experience that enhanced their understanding of their own students. Teachers also reported increased student engagement in STEM-PBL lessons).</p>	<p>(i) self-report data sources used, (ii) possible selection bias (teachers already had an interest in integration prior to PD), (iii) generalisation difficulties (specialist teachers in middle school settings), (iv) inadequate description of some data sources/analyses</p>	<p>Conference Proceedings/ Papers</p>





Graham (2016) United States	This study examined the impact of STEAM lessons on physical science learning in grades 3 to 5.	Quasi-Experimental (Treatment: n=2156, Control: n=5682; Standardised District Tests of Science)	Children in Grades 3-5 (N=7838)	Beyond reference to the work of Dewey, no particular model to summarise STEAM approaches to CI are provided. However, the author does offer a strong justification as to why the arts can support students' scientific reasoning (e.g. supporting abstraction, developing readiness etc.	The study found that students exposed to the STEAM lessons demonstrated greater improvement on physical science benchmark assessments than students exposed to a STEM-only physical science curriculum. With models controlling for confounders, Cohort 1 (teachers only after PD) saw moderate improvement in scores compared with control students (0.35 of a SD) and Cohort 2 (teachers + teaching artists) had slight improvements in benchmark scores over the control group (0.10 of a SD). The authors made the following statement to demonstrate the impact of their results: this amounts to an improvement, with a student moving from 50th percentile to 63rd percentile in the targeted curriculum when assigned a teacher well-trained in the STEAM curriculum, all other factors equal. A student could move from the 50th percentile to 63rd percentile in the targeted curriculum when assigned a teacher well-trained in the STEAM curriculum, all other factors equal.	(i) intact groups, (ii) limited range of outcome measures (i.e. only Science was assessed), (iii) potential novel effect (9 hours)	Journal Article (Peer Reviewed)
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**Gray (2022)
United States**

This study examined the effectiveness of 'Zoology One: Kindergarten Research Labs', developed by American Reading Company. This is a full-year curriculum that involves 120 minutes of daily integrated science/literacy instruction (e.g., read alouds, direct instruction in reading/writing, levelled texts, hands-on science inquiry),

Multi-site cluster-randomised controlled trial (decoding & comprehension measured by the Woodcock Reading Mastery test, 3rd edition; reading and letter name fluency measured by the Developmental Reading Assessment and AIMSweb curriculum-based assessment; writing measured by the Kaufman Test of Educational Achievement; science measured by researcher-designed instrument; motivation to read measured by the Kindergarten reading Motivation Scale)

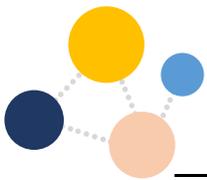
Kindergarteners from 71 classrooms in 21 schools (N=1589)

Students in kindergarten classes partook in units of teaching that integrated science and literacy, following a prescribed program.

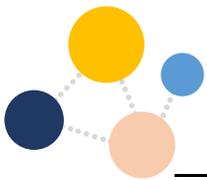
Treatment group scored higher on (i) passage comprehension $n(b=1.90, t(771) = 2.11, p = 0.035)$, Glass's Delta effect size of 0.16 (ii) letter naming fluency $(b = 8.35, t(459) = 2.02, p = 0.044)$, Glass's Delta effect size of 0.28, (iii) reading motivation $(b = 0.11, t(716) = 4.58, p < 0.0001)$, Glass's Delta effect size of 0.32. There were no difference on measures of: word attack, word identification, word comprehension, science knowledge, general reading outcome (DRA), writing outcomes. These effects were replicated within subgroups (language, gender etc). Fidelity of implementation had varying effects on different measures.

(i) A researcher-constructed item was used for science, (ii) a very large block of time (90 minutes) was available of integrated literacy/science instruction daily - this may not be possible/replicable in other jurisdictions

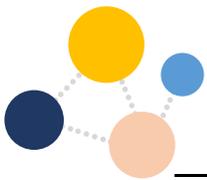
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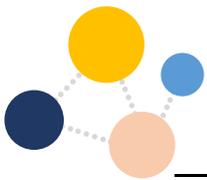
Greenwood (2013) Northern Ireland	This study examined responses from teacher questionnaires and interviews to understand relevant stakeholders' perspectives on the value of integrated learning approaches for learners in Northern Ireland.	Mixed Methods (Interviews; Surveys)	In-Service P5 and P6 Teachers (Interviews: n=6; Surveys: n=225)	The authors note that they use the terms 'cross-curricular' and 'integrated' interchangeably. To them cross-curricular, integrated approaches to teaching 'attempt to bring together within the same unit of work or topic, aspects from different subject areas which are taught concurrently, and which contribute in a meaningful and appropriate way to the unit's whole'. Each topic has a 'core' content that aligns closely with one or two key disciplines.	The author compared teachers' responses to their 2010 survey with a 2005 survey (Greenwood, 2007) which queried the geography based topics which were then being taught and the levels of cross-curricularity (CC) used for each topic. In 2005, the mean CC figure for all geography-based topics taught in P5 and P6 was 2.93; in 2010 that figure had risen to 3.64 (SD = 0.93). Teachers had, over a period of 5 years, become more comfortable with increasing the amount and type of CC teaching. From the interviews, the following positive aspects of CC were identified: 'connected' learning to allow learners to see the relevance of what they are doing, improved skills development and motivation, teacher enjoyment and empowerment. However, disadvantages were also noted: contrived links, concerns over diluted curricula, loss of science skills and content. Approximately 715 of the 225 respondents were classified as being broadly positive in their attitude to the move towards CC teaching.	(i) self-reports of CC practices can be problematic, (ii) researcher-design materials [surveys]	Journal Article (Peer Reviewed)
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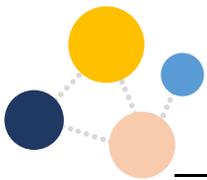
<p>Hahn (2020) United States</p>	<p>This study examined teachers' experiences with collaboration as part of a professional development programme for arts-integrated instruction. This study was conducted in 2020, during the initial months of the Covid-19 pandemic causing the participants of the PD programme to conduct their work to an online environment.</p>	<p>Case Study (Interviews, Field Notes, Participatory Action Research, Artefacts)</p>	<p>Pre-Service (N=1) and In-Service Teachers (N=4)</p>	<p>The author acknowledges that there is a 'spectrum' of definitions to describe arts integration. Consequently (and in line with the principles of the PD programme involved in the study), multiple sources are used to construct a definition of integration. In this study, Beane's (1997) definition of transdisciplinary integration (whereby concepts that transcend subject boundaries should be used to inform instructional design) with elements of Marshall's (2014) recommendations (practical guidance for transdisciplinary classrooms) were used. Collaboration to support interdisciplinary practice was also incorporated into the framework that examined teachers' adoption and understanding of arts-integrated pedagogies.</p>	<p>Collaboration was a "bright spot," of the PD whereby collaboration with peers allowed the participants to 'better' themselves, their teaching (curriculum design, instructional app and their communities. The online environment however, did hinder teacher experience of the PD programme (feeling disconnected, fewer opportunities for collegiality). The author noted from this (and other data) that virtual learning spaces have clear boundaries that can result in negative 'wall-building' and/or more positive 'wall-dissolving'.</p>	<p>(i) study didn't fully acknowledge the difference between online learning and emergency remote teaching (and how that would impact on a range of issues), (ii) potential experimenter bias (researcher worked in the institute - socially desirable responding), (iii) generalisability (i.e. highly specific context), (iv) short intervention time</p>	<p>Doctoral Thesis</p>
<p>Halimah (2021) Indonesia</p>	<p>This article examines the impact of a unit of cross-curricular learning involving indoor and outdoor environmental settings in order to develop local culture literacy (using a musical instrument called an angklung) among learners.</p>	<p>Case Study (Observations, Focus Groups, Artefacts [photos])</p>	<p>4th Grade Learners (N=24) and their class teacher (N=1)</p>	<p>No particular model or conceptualisation of integration was invoked for this study. The study examines how different curricular areas can support cultural knowledge and literacy among children.</p>	<p>The authors highlight how the use of an artefact (i.e. angklung) can support the development of cultural knowledge in a cross-curricular way provided that the subjects in question involve listening, speaking, reading and writing (i.e. 'multimodal' opportunities are plentiful). Students gained good knowledge of their local culture based on the use of a researcher designed rubric.</p>	<p>(i) researcher bias/power imbalance, (ii) self-selection bias (teacher volunteered because he was interested in the study), (iii) insufficient diversity in data sources, (iv) researcher designed materials, (v) short intervention duration</p>	<p>Journal Article (Peer Reviewed)</p>



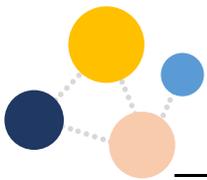
Hall-Kenyon (2013) United States	<p>This is a self-study in which a science and a literacy teacher educator document, analyse and reflect on a two-year collaboration to integrate their disciplines within an ITE programme.</p>	<p>Self-study (transcribed conversations; instructional materials jointly created)</p>	<p>Teacher educators (N=2)</p>	<p>This study is grounded in a comprehensive review of the literature on integration, but no one model appears to be endorsed. The authors generate their own definition of integration: "Thus, for us, curriculum integration is instruction during one lesson that is based on two or more objectives from two or more subject areas, which are (i) explicitly taught and assessed, (ii) authentic to the discipline and its discourse, and (iii) represent a natural connection between the subject areas, thus supporting and honouring the key ideas and nature of each discipline." (p.102)</p>	<p>Due to the qualitative, self-study nature of his paper, findings are reported at length. Key findings included: (i) both teacher educators had varying perceptions, backgrounds and introductions to integration, (ii) the extant definitions did not capture their shared understanding of integration; they both feared that 'infusion' models of integration did not do full justice to the disciplines being integrated; three key points of dissatisfaction with extant literature included: a) intentionality - whether there were explicit learning objectives for both subjects being integrated; both should be included; b) authentic practice - the disciplines must be authentically represented (writing a poem in science was considered a non-example of authentic practice); c) natural connections should be given precedence; they should not be forced</p>	<p>(i) Not necessarily generalisable (though this is not an aim of self-study), (ii) lack of PST/student data</p>	<p>Journal Article (Peer Reviewed)</p>
Hammond (2017) Dubai (English curriculum primary school)	<p>This study examined the rationale for, and impact of, an integrated curriculum on pupil understanding and pedagogy use in the primary classroom.</p>	<p>Case Study (Naturalistic Observations of classrooms, staff meetings; artefacts from classrooms [photos])</p>	<p>Primary School (N=1)</p>	<p>The author's discussions and views on integration are heavily influenced by Bernstein (1975; 2000), Erikson (2002), Nikitina (2006) and Maton (2006; 2009). The author relies heavily on Bernstein's (2009) conceptualisation of integration in their discussions i.e., integration means the subordination of a subject to some relational idea that blurs the boundaries between subjects. Such ideas should be at the 'supra-level' and framed within an inter-disciplinary approach to CI.</p>	<p>Successful elements/features/outcomes of the integrated curriculum included: Various levels of questioning to deepen understanding (- 'factual', 'conceptual' and 'provocative'), Using a text to engage/hook, Discrete exploration of the concept before launch, Allowing the abstract to be taught contextually rather than discretely, More opportunities for independent learning, Learning was deepened, Transference –applying previous learning to new contexts (near lower order transference), Development of subject specific language (in some areas), Talk for writing, Exposing children to the correct terminology, Independence – selecting the correct tools for the job, Transference over time, High levels of engagement, Enrichment to support/contextualize the curriculum.</p>	<p>(i) unable to generalise many of the findings (which the author acknowledges), (ii) potential researcher bias (researcher's own school [in which he was the Head Teacher] was the case study), (iii) insufficient diversity in data sources (naturalistic, unstructured data observations from classrooms and meetings were the primary sources of data), (iv) inadequate rigour in analysis of qualitative data</p>	<p>Doctoral Thesis</p>



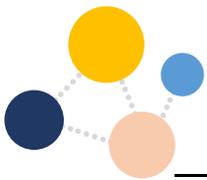
<p>Hardiman (2019) United States</p>	<p>This study examined the effects of arts-integrated lessons on long-term memory for science content. The paper describes the results of a randomized control trial involving 5th grade learners that measured retention of science content using arts-integrated science units and matched units employing convention science instruction.</p>	<p>Randomised Control Trial involving classroom-matched pairs involving equivalent control groups with condition reversal (Pre-, Post- and Delayed Post-test data gathered: Curriculum-Based Assessments)</p>	<p>5th Grade Learners (N=350)</p>	<p>This study defined arts-integration as 'a pedagogical method for teaching non-arts academic content in which both non-arts and arts-based standards are addressed' (p. 26).</p>	<p>No statistically significant difference between percent of retained content in the arts-integrated instruction condition versus the conventional instruction condition was noted (p = 0.721). 'Basic' readers remembered significantly more science content learned through the arts at the delayed post-test than basic readers who learned science through conventional methods (p=.029). There was no effect of arts-integrated instruction for different science units (e.g., Astronomy, Chemistry, Life Science etc.) by student reading level. A treatment by order effect was found: students who took arts-integrated science in the first session remembered more science in the second session when they learned science through conventional lessons.</p>	<p>(i) possible novel effect (arts-integrated science lessons were taught over a period of 4-6 weeks), (ii) arts-integration was a pedagogy in this study - art content was not a key element of the intervention, (iii) researcher-designed outcomes measures (based on the content taught), (iv) possible experimenter effect (classroom teachers taught both the arts-integrated and conventional curricula)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Harris (2015) United States</p>	<p>This study focuses on how middle school teachers used a variety of geographic resources to integrate their teaching of history and geography.</p>	<p>Observations using eight indicators; teacher resource logs - use of materials throughout the year; teacher ranking forms - how useful resources were</p>	<p>Practicing middle school teachers (N=37)</p>	<p>The authors outline conditions under which geography and history can be meaningfully integrated; no specific model of integration is invoked. Previous studies that have been critical of social studies integration are cited.</p>	<p>Resources were used in a variety of ways to support history/geography integration. For example, laminated maps were used to map out the travel of the Black Death and the Crusades. Some resources were rated more highly than others, but all received good reviews. Observational data revealed that teachers were most likely to use laminated maps and the Atlas of World History in lessons. The authors conclude that certain topics are 'ripe for integration'; others may not lend themselves so well to integration.</p>	<p>(i) Limited observations, (ii) very specific focus on use of resources, (iii) no collection of student data, (iv) some data only provided by sub-sample of teachers, (v) lack of comparison group</p>	<p>Journal Article (Peer Reviewed)</p>



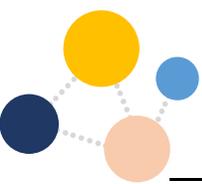
<p>Harris (2019) United States</p>	<p>This study examined the impact of the integrated/interdisciplinary approach to teaching on 4th grade learners' achievement in standardised tests in literacy, numeracy and science. Test scores (PARCC, ASK-4 [New Jersey] from 2014-2017 for a randomly selected grouping of 50 schools using integrated-interdisciplinary curriculum and 50 schools using subject-specific curriculum were analysed to address this research question.</p>	<p>Large Scale Assessment Analysis [Ex-Post Facto Design involving a comparison of schools who used an integrated-interdisciplinary curriculum (n=50) or a subject-specific curriculum (n=50)] (Grade 4 PARCC Assessment; ASK4-Science Assessment [2014-2017])</p>	<p>Schools (N=50)</p>	<p>The author uses 'interdisciplinary' and 'integrated' curriculum interchangeably but does note some minor differences. For example, the former is simply a 'way of teaching and learning that does not depend on the usual division of knowledge into separate subjects' (from ASCD, 1997). The latter is similar but is distinguished by the fact that the content for an interdisciplinary curriculum must be drawn from two or more identifiable disciplines (ASCD, 2016). When discussing the enactment of integrated/interdisciplinary curricula, the author advocates a constructivist approach. The study itself examined the role of interdisciplinary mathematics and science instruction in great detail.</p>	<p>RQ1: A significant difference was found to indicate that an integrated-interdisciplinary curriculum increased fourth grade students' academic achievement in language arts as measured by the New Jersey PARCC. In all 3 years of the study, the curriculum was the strongest predictor of language arts student achievement scores. However, other variables were also significant predictors (e.g. ELL, SES) for different years. RQ2: A significant difference was found to indicate that an integrated-interdisciplinary curriculum increased fourth grade students' academic achievement in mathematics as measured by the New Jersey PARCC. In all 3 years of the study, the curriculum was the strongest predictor of mathematics student achievement scores. However, other variables were also significant predictors (e.g. ELL, SES) for different years. RQ3: A slight significant difference was found to indicate that an integrated-interdisciplinary curriculum increased fourth grade students' academic achievement in science as measured by the New Jersey ASK4-Science assessment. In 2015, the strongest predictor of science achievement was negatively impacted by the SES predictor, but in 2016 and 2017, the curriculum was the strongest predictor of science student achievement scores. The influence of the integrated-interdisciplinary curriculum over time shows a slight increase in scores for language arts and mathematics, but a slight decrease in science scores.</p>	<p>(i) generalisability issues (e.g. one state, highly specialised and specific assessments), (ii) implementation of integrated curricula may have varied between schools and settings (i.e. schools self-identified as integrated or otherwise), (iii) use of PARCC scores may be problematic in terms of sampling (e.g. parents not permitting students to take them etc.) and administration ('14-'17 involved the transition to computer-based testing which did lead to validity issues with the scores, (iv) range of outcome measures examined, (v) schools were only paired by the grade level configuration of the school population - SES may have influenced analyses as the schools were not evenly matched on this variable ('traditional' schools had double the percentage of low SES learners in their schools compared to the CI schools)</p>	<p>Doctoral Thesis</p>
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Hastie (2013) United States	<p>This study investigated a unit of integrated PE (sport education) and science (animals/life sciences) that took place in one school over a six-week period.</p>	<p>Interviews (no further methods/design are mentioned)</p>	<p>2nd to 5th grade in one elementary school</p>	<p>Ackerman's (1989) criteria for judging the quality of integration is central to this study.</p>	<p>Findings are reported under four key themes: (i) Excitement: Students were very engaged in the unit; this was attributed to the focus on animals, the use of teams, the collective component of working with the whole school, (ii) Expanded coverage of content: greater depth was facilitated by the increases in time allocation allowed by integrating; content was reinforced across grade and subjects; students were exposed to more challenging material from an earlier age, (iii) innovating in this way required commitment from the school personnel (time/preparation/planning), (iv) the PE teacher played a critical role in the success of the unit.</p>	<p>(i) Lack of information on the design/origin of the project, (ii) reliance on self-report data, (iii) potential researcher effects, (iv) lack of objective measures, (v) data only gathered from teachers - learner outcome data not available, (vi) lack of observational data, (vii) limited description of the research methodology</p>	<p>Journal Article (Peer Reviewed)</p>
Havice (2018) United States	<p>This study examined the long-term effectiveness of a programme for professional development delivered by the 'Integrative STEM Education Institute' in South Carolina. Data were gathered from some participants immediately after their completion of the PD programme (2015/2016) and more data were collected from 'alumni' members (2012-2015). The PD programme aimed to develop participants' knowledge and skills to create and implement integrative STEM education activities for use in their classrooms. Problem-based and project-based learning was given particular attention in the programme.</p>	<p>Quantitative (Pre-Post Data gathered with a Researcher-Designed Survey)</p>	<p>In-Service Teachers and Administrators (N=74)</p>	<p>The authors emphasise the use of 'integrative STEM' which 'places engineering and technological design at the center of instruction, which facilitates connections being made across science and mathematics concepts' (from Sanders, 2009). No other discussions or conceptualisation surrounding STEM or curricular integration were provided.</p>	<p>For the 2015/2016 cohorts, all participants reported higher levels of proficiency and expertise after the Institute than when they first arrived. The differences in participants' perceived levels of proficiency and expertise in relation to STEM were calculated to be statistically significant. According to the results of the alumni survey, 73.80% (n = 31) of alumni indicated that they were able to introduce integrative STEM education pedagogy in their classrooms. All but five of those participants, reported that they had found a way to build a sustainable integrative STEM education program at the time of the alumni survey.</p>	<p>(i) sampling issues (i.e. one pre-test had 42 participants but the post-test had 29 participants), (ii) researcher-designed instruments, (iii) self-report measures used, (iv) inadequate reporting of statistical analyses</p>	<p>Journal Article (Peer Reviewed)</p>

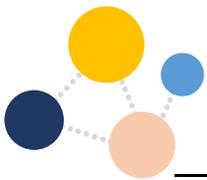


<p>Hawley (2022) United States</p>	<p>This study examines how teacher candidates make connections between literacy and mathematics during the course of their ITE programme.</p>	<p>Case study (video recordings and field notes of lectures/classes; coursework; instructor course documents; focus group interviews)</p>	<p>Pre-service teachers (N=13) undertaking mathematics/literacy courses, as part of a case study.</p>	<p>In this study, connections between mathematics and literacy are conceptually founded on (i) curriculum integration, broadly defined - no one model of integration appears to be endorsed, (ii) language as a basis for learning (e.g. vocabulary, reading in mathematics), (iii) similarities in teaching and learning mathematics and literacy (e.g. in similar pedagogies, learning goals and in thinking skills); the study examined how these two areas of the curriculum are linked by pre-service teachers.</p>	<p>(i) Curriculum integration was not regularly invoked as a connection between areas by teacher candidates during classes, (ii) language as a basis for learning - reading, listening, vocabulary etc. - was more likely to be invoked, (iii) teacher candidates identified similarities in approaches/purposes between mathematics and literacy (e.g. both involve a process that support sense-making; both involve multiple perspectives or solution strategies; both require some choice and connection to children's lives). The author concludes that: greater focus needs to be placed on integration in ITE programmes, including decompartmentalisation; disciplinary literacy requires further attention.</p>	<p>(i) Focus on ITE programme rather than practicing teachers, (ii) small sample size</p>	<p>Doctoral Thesis</p>
<p>Heimer (2015) United States</p>	<p>A case study of integrative/interdisciplinary practice on one ITE programme that specifically endorses interdisciplinary teaching.</p>	<p>Case study (surveys, interviews, artifact analysis)</p>	<p>Pre-service early childhood teachers interviewed (n=5); Pre-service early childhood teachers surveyed (n=30); teacher educators (n=5); [1 case study teacher preparation programme; N=36 on programme overall]</p>	<p>Integration is framed as an interdisciplinary endeavour that draws connections across multiple disciplines. The study focuses on how pre-service teachers integrate material from across various courses (e.g. social studies, literacy, mathematics) both in their classwork and on placement.</p>	<p>Four main themes are reported: (i) Understanding and articulating interdisciplinary teaching: PSTs found it difficult to articulate an understanding of interdisciplinary teaching, but faculty had more nuanced views (ii) PCK as it relates to interdisciplinary understanding: PSTs' knowledge varied from subject to subject; PSTs were more confident with subjects that received more instruction on the programme, (iii) Authentic or superficial integration?: in coding PST sample units, researchers concluded that it is difficult to determine if integration is authentic; most students demonstrated at least some authentic integration in their units, (iv) Linking an interdisciplinary approach to practice: there were tensions between the child-centred integrative practices recommended on the programme and the approaches experienced by PSTs on placement (practicum). The authors concluded that enacting interdisciplinary teaching was challenging, even when the ITE programme was built around it. They recommend high levels of faculty collaboration, interdisciplinary</p>	<p>(i) Bounded case study, (ii) only small portion of PSTs actually partook in interviews, (iii) stipend was offered to participants, potentially introducing bias</p>	<p>Journal Article (Peer Reviewed)</p>

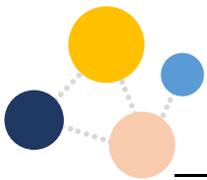


pedagogical modelling and well-planned placements.

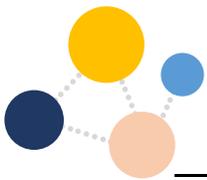
<p>Hieu (2019) Vietnam</p>	<p>The research aimed to identify what should be considered the 'basic competency components' of teachers aiming to implement integrated science teaching at primary schools. Using cross-sectional surveys, the authors asked in-service teachers and educational managers to consider the necessity of a range of competencies for integrated teaching e.g. capacity to define teaching objective, capacity to connect lesson content and practice. The respondents were also asked to consider the need for professional development across each of the stated competencies.</p>	<p>Quantitative (Cross-sectional Surveys)</p>	<p>In-Service Teachers, Educational Administrators (N=97)</p>	<p>While the study title does prioritise an integrated approach to teaching science, the survey conducted focuses on integrated teaching as a more general concept. After conducted a general literature review, the authors identified nine 'competency components for integrated teaching' (Capacity to Define Teaching Objectives, Capacity to Plan Integrated Teaching, Capacity to Design Integrated Teaching Lessons, Language Competence in Integrated Teaching, Capacity to Design and Create an Integrated Teaching Environment, Capacity to Organize Integrated Teaching, Capacity to Evaluate Learning Outcomes).</p>	<p>Most teachers and educational managers agreed with the necessity of the basic components identified by the authors and would like to have continuous professional development courses for fostering these competencies. Based on the survey responses, the authors also argue that competencies for integrated teaching can be summarised under two broad headings: (i) professional knowledge and understanding, (ii) professional skills and practice. The authors then develop a range of 'competency standards' under these headings.</p>	<p>(i) Difficult to disaggregate responses between administrators and teachers, (ii) Study is poorly written, (iii) Conceptual Framework has not been sufficiently justified, (iv) Link between study outcomes and competency standards identified are unclear and tenuous</p>	<p>Conference Proceedings/Papers</p>
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<p>Hipp (2019) United States</p>	<p>This study examined the self-reported factors that challenge and support pre-service teachers' arts-integration practices and beliefs.</p>	<p>Case Study (Reflective Journals)</p>	<p>Pre-Service Teachers (N=74)</p>	<p>Based on their examination of the literature (e.g. Aprill, 2010; DeMoss & Morris, 2002), the authors offered this definition of arts integration: 'Arts integration is a pedagogical approach providing opportunity to achieve curricular goals by having students create through an art form and connecting instruction between the art form and core curriculum,(p.4). They note that this means that most US arts curricula can be identified as 'arts as curriculum' or 'arts enhanced curriculum' which involves the teaching of art or the use of art in teaching a subject area concept. They also use the Kennedy Center's definition of Arts-Integration to further emphasise the role students play in arts-integrated instruction, specifically how they 'engage in a creative process which connects an art form and another subject area and meets evolving objectives in both' (from Silverstein & Layne, 2010, p.1).</p>	<p>Challenges and supports associated with the implementation of arts integrated teaching at the elementary level were identified by the pre-service teachers. Challenges (classified as 'needs', 'barriers' and 'excuses') included: time, resources, professional development, funding, knowledge, lack of 'easy to implement' classroom approaches [and support from mentor teachers on placement], accountability measures (e.g. standardised tests). Benefits to arts integration included: collaboration, value, ease of addressing student needs, higher order thinking skills, passion.</p>	<p>(i) convenience sampling techniques used, (ii) researchers were the pre-service teachers' lecturers (power imbalance/ socially desirable responding), (iii) limited range of data gathered/analysed</p>	<p>Journal Article (Peer Reviewed)</p>
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<p>Hourigan (2021) Ireland</p>	<p>This study reports the STEM education perspectives held by key stakeholders in Irish primary STEM education (i.e., primary teachers, teacher educators). Novice STEM teachers were interviewed about their STEM perspectives prior to their involvement in a PD programme for STEM (n=27) and expert STEM teachers completed the survey at the end of this 3-year PD programme. Ten expert STEM teachers and three other relevant stakeholders within the Irish education system were interviewed to determine their beliefs regarding integrated STEM education.</p>	<p>Qualitative (Interviews, Surveys)</p>	<p>In-Service Teachers (N=49) and key stakeholders (N=3)</p>	<p>The study offers a careful examination of how STEM integration has been conceptualised in the literature, acknowledging the difficulties the field has had in developing guiding principles for educators given the range of definitions and implementations of STEM in primary classrooms. No one single approach or definition to integrated STEM education is highlighted as being optimal but work by Vasquez et al. (2013) and Moore et al. (2014) is discussed.</p>	<p>(i) Thematic data analysis identified three predominant themes: (i) Limited conceptions of integrated STEM education among novice STEM educators, (ii) Robust definitions of integrated STEM education among experienced STEM educators, and (iii) Consensus regarding the level of primary STEM integration. Regarding the first theme, there was no relationship between teachers' conceptions of STEM education and their years of teaching experience. In relation to the second theme, some expert teachers noted that they viewed STEM as a methodology involving a student-led approach, collaboration and hands-on, authentic tasks and activities. In terms of the number of disciplines required to be considered an integrated STEM activity, one stakeholder acknowledged '... it's very difficult to do all the four'. For the final theme, there was agreement among participants that individual teaching of disciplinary content was necessary. The majority of expert STEM teachers reported taking a thematic approach, connecting STEM across a range of subjects within and outside the STEM disciplines, thus indicating a multidisciplinary and interdisciplinary emphasis.</p> <p>The findings arising from the analysis of data evidences the impact of effective STEM education professional development.</p>	<p>(i) limited range of data gathered, (ii) sampling bias, (iii) operational definitions of novice and expert teachers</p>	<p>Journal Article (Peer Reviewed)</p>
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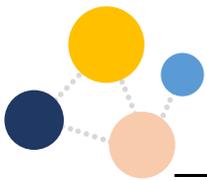
Hraste (2018) Croatia	This study examined the efficacy of an integrated mathematics/geometry and physical activity program for 4th grade pupils.	Experimental Design (Pre-Post Data with control: Researcher Designed assessment of relevant geometry concepts; National School Program approved mathematics test)	4th Grade Learners (N=36; Control: n=17, Treatment: n=19)	No in-depth description or conceptualisation of curricular integration is provided in the paper beyond this statement: 'The integrated approach consists of the planning and organization of the teaching of different disciplines and is considered to be a more effective method of teaching when the new knowledge presented is related to already well-known concepts' (p. 2).	The results of factorial mixed design between/within the 2x2 ANOVA showed a statistically significant impact of 'group' on achievement i.e. participants who gained their mathematics and geometry knowledge through the integrated Maths/PA approach were significantly more successful (P<0.05) than the control group.	(i) researcher designed materials, (ii) no underlying discussion informing the integration of PA and maths (i.e., seems 'surface level'), (iii) PA and PE are not interchangeable - PA is a part of PE (i.e. generalisability issues), (iv) short intervention time/novel effect, (v) intact groups, (vi) small sample size	Journal Article (Peer Reviewed)
Huang (2012) Taiwan	This study examined the different approaches undertaken by elementary school teachers for music integration. This study investigated differences and relationships between styles of integration [as defined by Bresler (1995)] and modes of collaboration [identified by the author to be: Collaborative Consultation, Peer Collaboration, Collaborative Partnership, School-Wide Collaboration], by region [Pennsylvania and Taiwan] and type of teacher [music specialists and primary/upper-level classroom teachers].	Quantitative (Researcher-Designed Survey)	In-Service Teachers (N=625)	The author first begins with a definition of arts integration, using Deasy's (2003) work i.e., Arts integration is "the effort to build a set of relationships between learning in the arts and learning in the other skills and subjects of the curriculum" (Deasy, 2003, p. 2). She then highlights that music integration, as a specific form of arts integration, can 'open up possibilities for comprehensive study while preserving the integrity and validity of musical experience' p. 6). Bresler's (1995) integration styles were chosen as the framework for this study (subservient, co-equal/cognitive, affective, social integration).	Significant differences in teachers' integration of music and collaboration with others existed by type of teacher but not by region; music specialists supported music integration and collaboration more than classroom teachers. Teachers' beliefs and practices regarding Integration Styles and Collaborative Modes significantly differed by type of teacher and region. Music specialists supported Coequal and Social Integration Styles more than classroom teachers. Pennsylvania teachers supported Subservient Style, and practiced Consultation, Peer and School-wide collaboration modes more than Taiwanese teachers.	(i) generalisability (teacher populations involved in this study were very specific to US/Taiwanese contexts), (ii) researcher-designed materials, (iii) self-report measures used, (iv) response rates varied significantly between groups	Doctoral Thesis
Hubbard (2020) United States	Teachers partook in job-embedded PD, supported by the researchers, which led to the development of integrated units in social studies, science and literacy. An instrumental case study design is used. Findings were mixed; teachers indicated that interdisciplinary teaching is	Instrumental case study (pre and post teacher surveys, focus group interviews, work samples, lesson study observation protocols; researcher journals)	In-service teachers (N=17), collaborating with teacher educators (N=3)		The outcomes were mixed, with many teachers feeling that they did not gain knowledge about integration or that they required further professional development over and beyond that involved in this study. Lesson observations demonstrated mixed results, with issues regarding the difficulty of the content for students.	(i) The authors indicate that there was limited buy-in from teachers in this study, (ii) they also cite a 'difficult situation' that required a change in principal during the study, (iii) no outcome measures	Journal Article (Peer Reviewed)



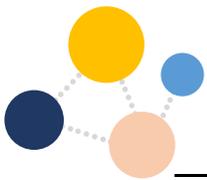
challenging and that further supports may be needed.

used, (iv) limited information provided on some of the data gathered

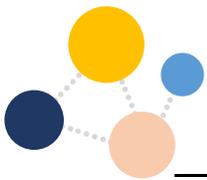
<p>Huck (2014) United States</p>	<p>This study examined two third grade teachers' perceptions and practices for integrating social studies with English Language Arts.</p>	<p>Case Study (Observations, Interviews, Artefacts [curricular documents, lesson plans, student work])</p>	<p>In-Service Teachers (N=2)</p>	<p>The author uses a definition by Parker (2001) to summarise content integration: 'a curriculum approach that purposefully draws together knowledge, perspectives, and methods of inquiry from more than one discipline to develop a more powerful understanding of a central idea, issue, person, or event. The purpose is not to eliminate the individual disciplines but to use them in combination' (Parker, 2001, p. 452). The 'Expeditionary Learning' modules that the teachers in this study used to support CI employ an 'interdisciplinary thematic unit' and the author uses those terms interchangeably throughout the thesis. The study is also heavily influenced by Bernstein's (1975) work regarding the interpretation of teachers' decisions on curricular/content integration.</p>	<p>Findings demonstrate that more social studies instruction occurs due to the adoption of a program that deliberately integrates social studies with English Language Arts ('Expeditionary Learning'). However, lesson focus remained unbalanced as it prioritised literacy concepts and skills (in order to ensure good test scores) causing the depth and focus of social studies topics to vary significantly. Teachers in this study worked from a scripted program, but adjusted activities based on students' needs (e.g. pacing) and were supported by building and district administration to do so, or to break from the script ('The modules are a framework'). Administrative control over curriculum and scheduling determined levels of teacher autonomy e.g. science/math units had to be completed in November, causing teachers to not engage with social studies content. Instructional choices were framed by administrative priorities and regulated teachers' ability to present social studies through an integrative structure.</p>	<p>(i) sample (self-selection, size), (ii) limited range of data gathered, (iii)</p>	<p>Doctoral Thesis</p>
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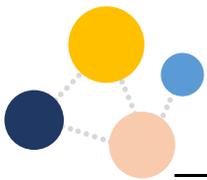
Huck (2019) United States	<p>This study examines how two elementary teachers integrate social studies and English/language arts. It is framed as a case study. The study is located in the broad context of the Common Core curriculum and preceding policy initiatives that diminished the time available for the teaching of social studies.</p>	<p>Multiple case study of two teachers, in the same school (observation, interviews, document analysis)</p>	<p>Elementary teachers (N=2) (third grade, fourth grade)</p>	<p>The following definition by Parker (2000) is endorsed: "a curriculum approach that purposefully draws together knowledge, perspectives, and methods of inquiry from more than one discipline to develop a more powerful understanding of a central idea, issue, person, or event. The purpose is not to eliminate the individual disciplines but to use them in combination (pp. 452–453)." The work of Hinde (2005) on social studies content integration is also foregrounded.</p>	<p>(i) Both teachers enjoyed teaching social studies, and saw benefits in integrating the subject with ELA (e.g. saves time), (ii) district curriculum maps were important for supporting planning, though they did not necessarily support integration - teachers needed to figure out these connections; the balance between which subject (ELA or social studies) received most attention varied; (iii) challenges included a lack of instructional time; state mandates; non-prioritisation of social studies by management; dearth of resources which are difficult to source; large amount of preparation needed to integrate; difficult to give equal attention to subjects in planning</p>	<p>(i) small sample size, (ii) large reliance on self-report/interviews in write-up</p>	<p>Journal Article (Peer Reviewed)</p>
Ichinose (2017) Japan	<p>This study draws on survey data from Japanese school leaders to evaluate how educational for sustainable development is taught.</p>	<p>Survey (researcher-designed questionnaire)</p>	<p>Head teachers (N=469)</p>	<p>The literature review outlines that educational for sustainable development is usually taught during 'integrated study time' in Japan, rather than in individual subjects. This study time dates to the 1998 revision of Japanese national standards. No model for curriculum integration is referenced.</p>	<p>The ESD calendar was regularly referenced by teachers and supported their integration ESD; some teachers indicated shifts towards learner-centred approaches (e.g. active approaches); teachers reported instances of collaboration that supported the delivery of ESD; they also instanced examples of using the local environment to support ESD; teachers indicated that students had become more aware of environmental issues, linking this with the study of the local environment; there were limited references to critical thinking and democratic decision-making in the responses; the tripartite nature of ESD (focus on environmental, social and economic dimensions) was not evenly represented in responses on local studies, with only one reference to the economy;</p>	<p>(i) Use of computer software to analyse qualitative data is problematic, (ii) reliance on self-report data, (iii) lack of detail provided on the survey instrument</p>	<p>Journal Article (Peer Reviewed)</p>



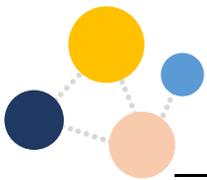
<p>Inoa (2014) United States</p>	<p>This study examined the impact of arts (theatre) integrated instruction on scores in mathematics and ELA/literacy.</p>	<p>Multi-stage cluster randomised trial (New Jersey state assessment in ELA/literacy, mathematics)</p>	<p>(N=1193) sixth and seventh grade students (n=464 control, n=729 treatment) from n=8 schools (4 control, 4 treatment, matched)</p>	<p>Burnafor et al.'s (2007) three categories of arts integration are cited: "arts integration as learning "through" and "with" the arts; arts integration as a curricular connections process; and arts integration as collaborative engagement" (p.3). The Integrating Theater Arts Program (ITAP) is framed as being consistent with each of these three categories. Broader conceptual models of curriculum integration are not cited. Theatre strategies are posited as supporting student preparation for writing.</p>	<p>The whole-of-grade results are as follows: (i) At sixth grade level, students in the arts integration group were significantly more likely to reach proficiency in state mathematics assessments ($X^2=8.441$, $df=1$, $p\leq.01$), but not in language arts; there was a significant difference in mean scores for literacy ($t(645) = -2.036$, $p=.042$) and mathematics ($t(645)=4.914$, $p=.000$), (ii) At seventh grade level, there was no significant difference in the number of students who reached proficiency in language arts/maths; neither was there a significant difference in mean scores for language arts/maths, (differences in breakdown by gender and ethnicity are also reported in the main paper)</p>	<p>(i) Results had to be disaggregated by grade level (6/7) due to a lack of homogeneity when pooled in the same sample - the authors point out that this reduced statistical power, (ii) no substantial/theoretical reason is offered for why scores were greater in the 6th grade sample than the 7th grade sample, (iii) no direct measures of *arts* knowledge/skills are reported - maths/literacy assessments may not be the most appropriate measures</p>	<p>Journal Article (Peer Reviewed)</p>
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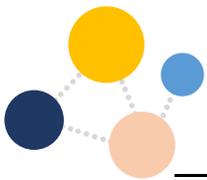
<p>Israel (2020) United States</p>	<p>This study examined the integration of computer science (CS) and computational thinking (CT) into elementary mathematics instruction by elementary school teachers from Grades 1-5.</p>	<p>Qualitative (Artefacts [Lesson Plans])</p>	<p>In-Service Teachers (N=13) with CS/CT coaches (N=2) [all based in one school)</p>	<p>The authors note that there are a range of conceptual frameworks to elucidate how content or curricular integration can occur. However, this study examined the extent to which CS and CT were integrated within mathematics instruction through the lenses of both Kiray (2012) and Vasquez et al. (2013) models of integration. In Kiray's model, 'if CS/CT is integrated into mathematics wherein the mathematics had more emphasis than CS/CT, that instruction would be considered mathematics intensive, CS/CT connected; if the opposite were true, the instruction would be CS/CT intensive, mathematics connected' (p. 364). For Vasquez et al. (2013), integration was described along a continuum of activities: '(i) no integration between content areas, (ii) multidisciplinary instruction in which instruction is taught separately but references common themes, (iii) interdisciplinary instruction where the disciplines are tightly linked, and finally, (iv) transdisciplinary instruction in which skills across disciplines are applied to answer central driving questions' (p. 364).</p>	<p>Key findings from the authors' analysis of the lesson plans gathered included: a) CS/CT concepts were taught with increasing complexity across the grades, (ii) the mathematics content was dominant and CS/CT was important but secondary, and (iii) three types of lessons emerged: No integration, partial integration, and full integration. Lessons generally transitioned from less integrated to more integrated activities with an initial focus on discipline-specific conceptual understanding prior to integrated activities</p>	<p>(i) limited range of data gathered, (ii) contextual factors may have influenced teachers' approaches (highly supportive of project) and may impact on generalisability</p>	<p>Journal Article (Peer Reviewed)</p>
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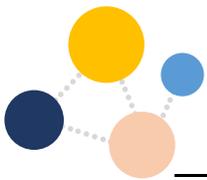
<p>Jamil (2017) United States</p>	<p>This study uses a mixed-methods approach to understand the beliefs of early childhood teachers who attended a professional development conference on STEAM teaching.</p>	<p>Mixed Methods (Survey, Interview)</p>	<p>In-Service Teachers (n=41 [Survey Data], n=4 [Interview Data])</p>	<p>The authors state that STEAM is a 'trans-disciplinary learning process that reaches across content areas and asks students to problem solve using real life scenarios' (p. 409). The study draws on a recent framework of effective STEAM education proposed by Quigley et al. (2017), known as the STEAM Classroom Assessment of Learning Experiences (SCALE) Model. This suggests that well-executed STEAM learning experiences must draw on a set of desirable knowledge (Instructional Content) and pedagogy (Learning Context) in order to achieve the powerful learning outcomes the approach promises.</p>	<p>Teachers varied in their beliefs about STEAM and the supports they needed to implement it successfully. Age, professional training and teaching experience did influence teachers' beliefs about the characteristics of STEAM. Themes related to early childhood educator beliefs about STEAM education included: (1) Focus on products (participants saw STEAM related activities to be very task orientated and wanted a 'product' to use immediately), (2) Priorities for instruction (some teachers queries the necessity of some STEAM tasks i.e. they did not correlate with what should have been learned but they were enjoyable at least), (3) View of children (concerns about behaviour management), and (4) Management (times, materials), .</p>	<p>(i) researcher designed instruments (albeit those that were underpinned by a clear conceptual framework), (ii) sample size/representativeness (teachers selected to attend this PD programme), (iii) short intervention time, (iv) self-report measures</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Jia (2021) China</p>	<p>This research examined the impact of a novel unit of work that aligned with the interdisciplinary principles of STEAM education and 'Maker' education on student's learning motivation, self-efficacy, and acquisition of interdisciplinary knowledge. The learning activities were designed using the engineering design framework as a guide.</p>	<p>Experimental Design (Pre-Post Data, no control; Instruments: (1) Learning motivation scale (adapted from Keller, 2009), (2) modified version of General Self-Efficacy Scale (GSES), (3) STEAM Test questions (from a multidisciplinary test bank), and (4) a researcher designed rubric to assess task completion by students.</p>	<p>3rd Grade Learners (N=164)</p>	<p>Difficulties surrounding the theoretical and conceptual features of STEM/STEAM are acknowledged by the authors, but they are not discussed.</p>	<p>Learning Motivation: The mean values for the dimensions of total score, attention, relevance, and satisfaction were all >3 (where 5 is the highest score) indicating (according to the authors) that learners were motivated to complete STEAM tasks; Self-Efficacy: Students' levels of self-efficacy to complete integrated STEAM tasks had significantly increased by the end of the intervention (p=.015; STEAM Scores: Students' acquisition of relevant STEAM knowledge following completion of the course was positive with an average score of 65.46 calculated from the assessment data gathered.</p>	<p>(i) role of research team is somewhat unclear in the write up (possible researcher effects), (ii) insufficient information on some of the instruments used (validity/reliability issues), (iii) Write-up of quantitative results lacks clarity, (iv) Hawthorne effect</p>	<p>Journal Article (Peer Reviewed)</p>



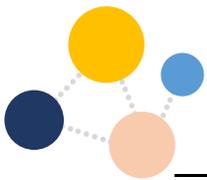
<p>Jordan (2016) United States</p>	<p>Four fifth graders embarked on a professional learning community with the goal of integrating social studies and literacy instruction. This led to the development of integrated units of work. Qualitative analysis of data from the PLC reveals the success and challenges of integrated teaching, with a specific focus on this method of PD as a tool for teacher learning.</p>	<p>Case study (PLC sessions, interviews, recorded lessons, artifacts)</p>	<p>Fifth grade teachers (N=4)</p>	<p>Integration is framed as an endeavour that supports inquiry and higher-order thinking. In practice, this study focused on the integration of ELA and social studies. A certain amount of circular reasoning is evident in the definition provided: "integrated curriculum refers to the integration of two or more subjects to be taught simultaneously" (p.9). Transdisciplinarity is invoked as a "unified approach to understanding a concept or idea" (p.9) and is, in the view of the author, represented in the questions/problems that students researched in the study.</p>	<p>Analysis of the qualitative data is organised in several themes: (i) looking at integrated curriculum supported teachers to review their content knowledge in two subjects at the same time; students integrated their learning in the brochures they created, though teacher perceptions of how successfully this was completed varied; the process of planning an integrated unit was complex and challenging from a time perspective (ii) Complexity in teacher knowledge: discussions as part of the PLC developed teachers understandings of curriculum standards and content; teacher understandings of connections between subjects developed, (iii) the PLC was found to help teachers learn from each other, change their own practices and examine/develop professional identity.</p>	<p>(i) There is some tension/ambiguity around how integration is conceptualised - Transdisciplinarity is invoked but needs to be more clearly elucidated, (ii) small sample size, (iii) researcher positionality may need further attention as they were in the joint role of researcher/participant, (iv) student outcomes are not measured</p>	<p>Doctoral Thesis</p>
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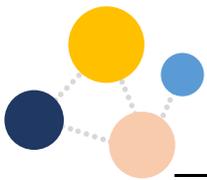
<p>Kennelly (2012) Australia</p>	<p>This study follows up with teachers who undertook a cross-disciplinary Education for Sustainability unit in their initial teacher education. It seeks to explore their actual practice/experiences as they commence teaching.</p>	<p>Multiple case study (interviews with the NQT form the basis for the paper [other tools included interviews with the principal/teachers/ancillary staff; classroom observation; documentary analysis; researcher diary])</p>	<p>Newly qualified teachers who had participated in an Education for Sustainability unit in their ITE (N=5)</p>	<p>No specific of model of integration is employed; the term 'cross-disciplinary' is used.</p>	<p>(i) Content knowledge: Having the depth of knowledge to meaningfully teach EfS was a challenge for some of the NQTs; the authors suggests that the research/primary source analysis in the ITE module supported this, (ii) Knowledge of instructional strategies: Experiential learning, in which PSTs actively participated in EfS methodologies appeared to support their enactment as NQTs, (iii) Knowledge of the primary curriculum: Three of the five teachers understood the integrated nature of EfS within the primary curriculum; one teacher expressed frustration and a lack of confidence in his ability to integrate EfS; experience with curriculum planning was seen as a crucial as part of ITE if EfS is to be enacted, (iv) Knowledge of children's understanding: Having taught students as part of the EfS module in university was seen to support teacher understanding of how to pitch material, (v) Conceptualisation of the wider purposes of EfS: Varying conceptions were apparent; e.g. two teachers saw EfS as a change process, (vi) Importance of context: School contexts did not all support EfS, which made it more challenging for NQTs to teach it</p>	<p>(i) Potential researcher effects (researcher inquiry regarding impact of own practice), (ii) high reliance on teacher self-report of practices</p>	<p>Journal Article (Peer Reviewed)</p>
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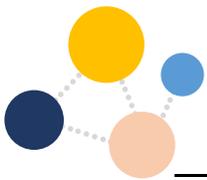
<p>Khanna (2021) United States</p>	<p>This case study described and examined how an urban elementary school implemented an arts integrated curriculum in order to identify the benefits and challenges for fourth and fifth grade students of colour (specifically African American and Latinx students) enrolled at the school.</p>	<p>Case Study (Interviews, Focus Groups, Observations, Artefacts [e.g. lesson plans, curricular documents])</p>	<p>Urban Elementary School (N=1; worked with 4th & 5th grade learners, teachers [specialist and generalist], parents and administrators)</p>	<p>The approach at the school involved in this research was primarily a constructivist informed, arts-integrated curriculum that was heavily influenced by the 'Different Ways of Knowing' theoretical approach (Johannesen, 1997; 2004 - funded by the Galef Institute). The author gives very good overview on the history or arts integration approaches and difficulties in its conceptualisation. The author did state that this definition of Arts-Integration was the most appropriate for this research (p. 47): "Arts integration is an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in the creative process to explore mutually-reinforcing connections between an art form and another curriculum area to meet evolving objectives in both" (Silverstein & Layne, 2010, as cited in Duma & Silverstein, 2014, p. 4)</p>	<p>Based on the data gathered, the author argued that the students' involved in the arts-integrated curriculum had increased levels of self-confidence, self-expression, development of imagination, engagement and empathy of and with others. When using such an approach, the teachers did note that 'an adjustment period' was needed e.g. not having text-books etc..</p>	<p>(i) generalisability (e.g. use of grade/specialist teachers in the school, disadvantaged students may have been overrepresented etc.), (ii) limited range of data gathered and examined, (iii) researcher bias (researcher was a member of the school board)</p>	<p>Doctoral Thesis</p>
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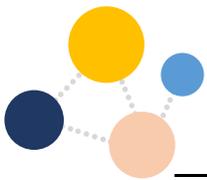
<p>Kim, D. (2017) Korea</p>	<p>This study examined the impact of a STEAM unit of work on pre-service teachers' perceived awareness and ability of as well as their value and commitment to STEAM planning and instruction.</p>	<p>Mixed Methods involving the collection of pre-post intervention data (Surveys [modified version of Mahoney's (2010) 'Test for attitudes towards STEM'], Artefacts [STEAM Lesson Plans])</p>	<p>Pre-Service Teachers (N=119)</p>	<p>The authors do not invoke any singular definition of STEM/STEAM education. Regarding the issue of integrated curricula, they simply state that this is an approach that 'draws together content from multiple disciplines' (p. 588). They acknowledge the difficulties in creating a single definition of IC given the range of approaches/conceptualisations involved. They appear to have relied heavily on Fogarty's (1991) work in their work with pre-service teachers.</p>	<p>Results show that developing STEAM lesson plans had a positive influence on elementary pre-service teachers' attitudes toward STEAM. Specifically, a significant improvement on a pre-post survey for participants' awareness, perceived ability, value, and commitment for STEAM was noted. Qualitative analysis of open-ended surveys revealed pre-service teachers' views of the potential benefits (enhanced knowledge/creativity/curiosity among learners, teacher confidence) and challenges (see below) of developing STEAM lesson plans. Pre-service teachers were asked to consider which of Fogarty's (1991) models was the most appealing. The most commonly selected forms were 'webbed' (25) 'shared' (30), and 'integrated' (31).</p>	<p>(i) translated and modified versions of surveys used [but it was well done in this case I admit], (ii) socially desirable responding/power imbalance (researchers worked with the students on their pre-service programme), (iii) generalisability to in-service teachers</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Kim, M.K. (2015) Korea</p>	<p>This paper reviewed key models of integrated instruction and from there developed the Convergent Concept Understanding Model to describe how integrated maths/science lessons could be undertaken in a 1st/2nd grade Korean classroom.</p>	<p>Case Study (Surveys [researcher-designed], Artefacts [Photos])</p>	<p>1st/2nd Grade Learners (N=37)</p>	<p>This study introduces a Convergent Concept Understanding Model to support the integration of science and maths. It was heavily influenced by constructivist learning theories (i.e., Piaget) and Lawson's Learning Cycle Model (1995).</p>	<p>The model explored in this study consisted of exploring a phenomenon, understanding a concept, and applying a concept. The authors applied this model to the design of an integrated science/maths unit on symmetry. The authors found that their approach contributed to raising students' interest in these subjects, and boosted student motivation to participate in learning activities.</p>	<p>(i) researcher designed instruments, (ii) quality/rigour of data analysis, (iii) researcher bias (role of researcher in the study was unclear), (iv) limited range of data gathered (e.g. no outcome data gathered)</p>	<p>Journal Article (Peer Reviewed)</p>



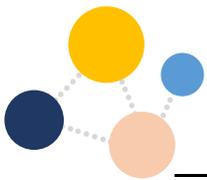
<p>Kim, M.K., Cho (2019) Korea</p>	<p>This study examined Korean elementary school teachers' perceptions of mathematics-focused STEAM education. A survey approach was used to determine how Korean teachers conceptualised STEAM education and what challenges are associated with its delivery.</p>	<p>Survey (Researcher-designed instrument)</p>	<p>In-Service Teachers (N=273)</p>	<p>The authors state that STEAM education is considered to be the 'convergence' of Science, Technology, Engineering, Art, and Mathematics. They pay particular attention to the role mathematics has in this approach arguing that there is a tendency to 'over-emphasise' the 'S' in STEAM education.</p>	<p>The results demonstrated that teachers recognized 'convergence' in STEAM education (as advocated by the Korean curriculum documents) either as an 'integrated approach' in which specific subjects or topics are taught together or as a 'convergent approach' involving a completely different approach to instruction. Teachers identified Science and Art as two 'easy' areas to integrate with mathematics. Positive responses were shown towards Math-Focused STEAM education in terms of its effectiveness on the education and needs of the students. A number of challenges were also identified in association with the delivery of maths-focused STEAM education i.e. lack of preparation time provided, materials, and educational resources. 65.2% of respondents stated that they would implement Math-Focused STEAM education if more support was provided.</p>	<p>(i) researcher-designed instrument, (ii) operational definition of key concepts were not clearly explained, (iii) analysis of qualitative data not fully explained</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Kirsten (2019) Sweden</p>	<p>This study examined the literacy practices discussed or enacted by groups of teachers participating in the 'Literacy Boost' national CPD programme in Sweden. The researchers analysed transcripts of the weekly CPD meetings undertaken in six schools to determine how literacy was integrated across a variety of subjects.</p>	<p>Not explicitly named, but essentially a Multiple site case study (recordings of CPD meetings; field notes)</p>	<p>Schools (N=6)</p>	<p>The study focused on how literacy was integrated with content area instruction across a variety of subjects. The authors propose that knowledge may be referred to in three main ways: (i) references to the *curricular content* of a school subject, (ii) (meta-linguistic) reference to the language of school in general, (iii) (meta-linguistic) reference to the specific language of a given subject.</p>	<p>The author concluded that four main teaching approaches were adopted by the teachers, though they were not adopted equally: (i) applying general literacy strategies to subject-specific teaching, (ii) defining subject-specific concepts, (iii) use of general strategies for literacy, loosely tied to a school subject, (iv) general literacy approaches not tied to a school subject. The author concludes that there was poor coherence between subject teaching and the literacy strategies used and poor attention to disciplinary literacy.</p>	<p>(i) Limited information is provided on the participants, (ii) no classroom observational/child outcome data gathered</p>	<p>Journal Article (Peer Reviewed)</p>



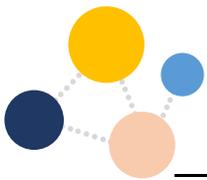
<p>Kloser (2017) United States</p>	<p>This study examined middle school teachers' conceptions of STEM education. In particular, the authors examined the relationships among and between each of the STEM disciplines.</p>	<p>Qualitative (Interviews, Artefacts [Cognitive Models])</p>	<p>In-Service Teachers (N=65)</p>	<p>The authors chart the historical development of the field of STEM education and note that despite significant interest in this area, definitions of STEM and how the individual disciplines relate to each other remain somewhat ambiguous. The author use this as justification for their current study.</p>	<p>Topic 1 Goals: The most frequently held views about the goals of STEM education from the participating teachers focused on affective measures e.g. promoting interest and engagement in STEM, developing grit etc., Topic 2 Pedagogy: Teachers' conceptions of how STEM is enacted in the classroom were captured along several continua: (i) instructional approach, (ii) disciplinary integration [i.e. problems should be solved by drawing on multiple disciplines), and (iii) contextualization. Topic 3 Relationship between STEM disciplines: (i) explicit connections between S.T.E.M. disciplines [Science, Math], (ii) individual S.T.E.M. disciplines in service of other S.T.E.M. disciplines [Technology as a tool]; and (iii) missing S.T.E.M disciplines [Engineering]</p>	<p>(i) research firm conducted the interviews (rather than the researchers), (ii) selection bias (teachers were involved in the project as they had an interest in STEM)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Kneen (2020) Great Britain</p>	<p>This study examined the experiences of a group of primary and secondary teachers in Wales who were engaged in creating a framework for an integrated curriculum for expressive arts in line with recent curricular reforms.</p>	<p>Qualitative (Interviews, Observations)</p>	<p>In-Service Teachers (N=11)</p>	<p>The authors offer a very effective overview of the literature surrounding curricular integration. Based on their analysis of the same, they state that 'integration 'is about making connections' across subject boundaries (Drake & Burns, 2004, p. 7)' (p. 262). They note that while they are working within the Welsh education system and are guided by the Draft Curriculum's definitions of CI, the curricular documents themselves do not offer consistent definitions of CI.</p>	<p>Theme 1: Opportunities of CI (Revitalising the role of arts in the Welsh curriculum, Creation of a new pedagogic framework [Explore & Experience, Create & Express, Respond & Reflect], Fluid movement between inter-, multi- and trans-disciplinary approaches, Increased student engagement, confidence and enjoyment). Theme 2: Challenges of IC for Primary Schools (Breadth/Depth of subject knowledge required for transdisciplinary approaches [leading to insufficient development of disciplinary knowledge, using vs teaching subject areas e.g. colouring vs colour theory, resources, access to Teacher Professional Development), Theme 3: Challenges of IC for Secondary Schools (Teacher Engagement, Subject Knowledge & Mastery)</p>	<p>(i) selection bias, (ii) inadequate description of analysis approach undertaken</p>	<p>Journal Article (Peer Reviewed)</p>



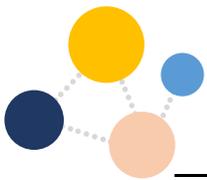
<p>Kok (2014) South Africa</p>	<p>This study examined pre-service teachers' knowledge of and views about an integrated pedagogy for science teaching. University teachers created an integrated numeracy, science and technology module for pre-service teachers, based on the science-technology-society (STS) approach (embedded in the South African 'Life Skills' subject that all elementary students engage with) to teaching science concepts.</p>	<p>Quasi-experimental (Researcher-Designed Rubric, Interviews, Focus Groups)</p>	<p>Pre-Service Teachers (n=168 [data came from groups whereby n=44 groups; Interviews: n=6, Focus Groups: n=10)</p>	<p>No in-depth description or discussion regarding the integration of science and technology processes was provided. The authors acknowledge that in their context (South Africa), the 'life skills' course that all elementary teachers should teach ' implies an integration of science, technology and social issues in stating, as a specific aim, that the life skills programme should expose learners to a range of knowledge, skills and values that strengthen their awareness of social relationships, technological processes and elementary science (DBE 2011a)'. Such an approach is underpinned by constructivist theories of learning.</p>	<p>Analysis showed a significant difference between the high and low scoring groups of pre-service teachers. Analysis of the rubrics indicated that they performed differently in the application of science concepts (e.g. insulation), maths concepts (e.g. understanding area and volume), communicating their understanding of dimensions and scale in 2D and 3D drawings (figures 2-3); and making accurately scaled models from their design drawings (figure 1). The authors claim that the project method for assessment of science concept application distinguished between student groups who could apply science concepts during the solving of a technological problem and those who could not. Three themes stood out from the qualitative data gathered: The use of the technological process; the need for practical classes; and the learning of science concepts through the use of the technological process (i.e. they would prefer to have science taught separately from technology)</p>	<p>(i) researcher designed materials, (ii) limited range of data gathered (thus limiting the validity of interpretations arising), (iii) insufficient consideration of possible confounders (e.g. group composition), (iv) inadequate description of the intervention/approaches used with pre-service teachers, (v) researchers were instructors on the pre-service teachers' course</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Kurup (2019) Australia</p>	<p>This study examined the beliefs, understandings, and intentions of pre-service primary teachers to teach STEM.</p>	<p>Survey (Researcher-Designed Survey that aligned with concepts from the Theory of Planned Behaviour [Ajzen & Fishbein, 1980] and a STEM Teaching Questionnaire [Prinsley & Johnson, 2015])</p>	<p>Pre-Service Teachers (N=119)</p>	<p>Bybee's (2013) STEM framework receives particular attention in this study which asserts that STEM education policies should align with this four-dimensional framework under the headings of: purpose, policy, program and practices. No discussions as to how the four subjects of STEM relate to each other were provided.</p>	<p>Findings from this survey indicates that pre-service teachers do not have a very strong understanding of STEM. However, they have strong beliefs and intentions to teach STEM in their future career. The pre-service teachers involved in the study noted that they needed more knowledge in order to teach STEM effectively. However, they also noted that their in-service teaching colleagues also needed this as well. This would only be addressed if STEM education was made a priority.</p>	<p>(i) self-report, (ii) representativeness of sample may be an issue according to the authors</p>	<p>Journal Article (Peer Reviewed)</p>



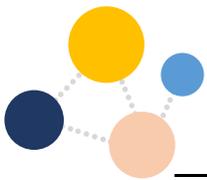
<p>Kuzich (2015) Australia</p>	<p>This study examined the experiences of Australian teachers integrating 'Education for Sustainability' into their daily teaching, learning and assessment practices.</p>	<p>Case Study (Interviews. Classroom Observations)</p>	<p>In-Service Teachers (N=11) and other staff (N=1) in the same purpose-built sustainability primary school situated in a 'green' suburb in Western Australia</p>	<p>No theoretical discussion on curricular integration was provided. Instead the authors discussed the emergence of sustainability as a cross-curricular priority (CCP) in the Australian curriculum. Sustainability as a CCP would allow it to permeate all learning areas, with teachers being encouraged to make links between them. The idea behind this was to ensure that sustainability was not understood as a discrete set of skills and knowledge, but rather as a way of thinking and doing that transcends subject boundaries.</p>	<p>Three types of infrastructure shaped the implementation of EfS at Amity Primary School: (i) policy infrastructure (ii) physical infrastructure and (iii) pedagogical infrastructure. In relation to Theme 1, it seemed that the affordance of Sustainability as a Cross-curricular Priority in the Australian Curriculum was difficult to benefit from as there was no actual mandate to teach EfS the lack of explicitness in the documents as to how to teach sustainability meant that there was 'wide latitude in how sustainability may be interpreted within formal documents and appropriated within the classroom'. Furthermore, the emphasis of literacy and numeracy due to annual NAPLAN testing meant that the schools often felt justified in prioritising these areas over sustainability. Regarding Theme 2, many physical aspects of the school environment have been purposely created to support EfS e.g. vegetable garden, a recycling programme, a grey-water scheme and a kitchen programme to illustrate the 'seed to table' cycle. However, other architectural features atypical to Australian schools also exist e.g. thermal bricks. While the school was very proud of these features it was difficult to fully maximise on them in their day-to-day work due to the unsustainable maintenance requires along with teachers' lack of knowledge/inability to fully utilise these features. For the final theme, the authors noted that EfS requires 'deep teacher knowledge of sustainability concepts'. Unfortunately, many teachers do not have this knowledge in the school when they arrive and they do not receive PD in this area - the school's focus is on literacy and numeracy.</p>	<p>(i) limited range of data gathered e.g. interview data</p>	<p>Journal Article (Peer Reviewed)</p>
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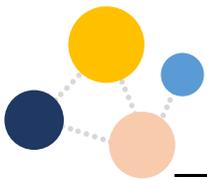
Lackovic (2015) Great Britain	This study draws on interview data with ten teachers to identify how a 2D/3D visualisation of a world heritage site might be integrated into regular curricular practice.	Interviews (semi-structured interview)	Teachers (N=10)	The term 'cross-curricular teaching and learning' is used to describe integration in this research. It is linked with the benefits of interdisciplinarity (citing Dewey) while also highlighting challenges (e.g. potential lack of rigour).	Teachers recognised potential for cross-curricular teaching in the 2D/3D rock art visualisations, offering a range of relevant examples for how it might be integrated (e.g. creative writing); teachers offered a variety of ways of including the visualisations that included what the researchers terms assimilation (i.e. using the resource to practice/develop a construct already being taught) and accommodation (i.e. using the resource to construct new knowledge); teachers articulated suggestions for improving interaction with the resource but also identified its potential benefits (relevance; scaffolded immersiveness; supporting constructivist teaching).	(i) Draws on hypothetical use of resource with children rather than actual resource, (ii) small sample size, (iii) focus on 2D/3D resource moreso than integrated curriculum	Journal Article (Peer Reviewed)
LaJevic (2013) United States	This study explores how elementary teachers understand, implement, and experience Arts Integration.	Case Study (Interviews, Focus Groups, Observations, Artefacts [student work], Document Analysis [curriculum documents, lesson plans, mission statements etc.]	1 school (N=6 elementary teachers; two kindergarten teachers, one first-grade teacher, two second grade teachers, and one art teacher)	The author notes that arts integration is 'generally defined as an arts focused approach to teaching and learning' (p. 2) but acknowledges that it is a complicated term with no universal meaning. Instead, she conceptualises AI as 'as a dynamic process of merging art with (an)other discipline(s) in an attempt to open up a space of inclusiveness in teaching, learning, and experiencing' (p. 2).	The author's key finding from their work centred around the devaluing of the arts in AI by using art as a 'decoration' (e.g. 'cookie cutter art'). The author noted that in interdisciplinary teaching, one subject is 'promoted' at the expense of another and the arts are often 'sacrificed'. The author felt that this was the case in their research, with art becoming 'an add on' rather than an integral part of the students' learning. As a result, the author felt that the students' were doing 'crafts' rather than 'arts' on many occasions.	(i) small scale study, (ii) researcher bias, (iii) not all teachers provided the same range of data (e.g. art teacher was not interviewed), (iv) inadequate description of analysis procedures	Journal Article (Peer Reviewed)



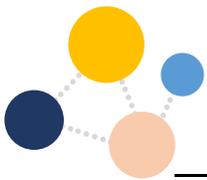
<p>Lamb (2015) United States</p>	<p>This study examined the content, cognitive, and affective outcomes related to STEM integrated curriculum for elementary school learners. The intervention used in this study was a whole school STEM integration curriculum designed by the STEM coordinator and district office.</p>	<p>Quasi-experimental (Pre-Post Data with control; Science Interest Survey [Lamb et al., 2012], Self-Efficacy in Science and Technology Short Form [Lamb et al., 2014], Paper Folding Task [Ekstrom et al. 1976] and the Shepard Metzler Test of Mental Rotation Task [Shepherd & Metzler, 1971], Science & Mathematics Content Exam [Pearson])</p>	<p>Kindergarten, 2nd and 5th Grade Learners (N=254; Treatment: n=111, Control: n=143)</p>	<p>The authors note that STEM learning is a broad area involving many disciplines and epistemological practices. However, the authors note that STEM can be conceptualised effectively when one focuses on student learning, offering the following definition: 'STEM learning is the acquisition of knowledge and skills through experience and study integrated through multiple lens allowing for the appreciation of the encompassing complexity and cross-cutting ideas across the STEM disciplines as a whole' (p. 410). Such an approach requires teachers to 'see across areas of interaction and the resultant complexity within the STEM disciplines' (p. 411).</p>	<p>An estimate of effect size of the mean group difference across the statistically significant constructs revealed that performance was practically better among those students in the Treatment condition: self-efficacy (d=1.27, large), science interest (d=1.97, large), spatial visualization (d=1.30, large), and mental rotation (d=1.42, large). There were no real differences between the groups on content learned. The ANOVA F-test results show that there are statistically significant differences on the measured constructs across the main effect of group F, accounting for 13% of the variance in scores between the groups (large). Post hoc tests indicated that the majority of the differences between the control and comparison groups happened in the 2nd or 5th grade, thus indicating that access to STEM education at earlier ages can have 'pay-off' at later stages.</p>	<p>(i) non-randomised, intact groups, (ii) suitability of some outcome measures (e.g. cognitive tests), (iii) insufficient attention to potential maturation effects in the analysis (but was present in the discussion), (iv) sampling biases (only certain age groups involved), (v) some self-report measures used (prone to bias)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>LaMotte (2018) United States</p>	<p>Students in an experimental group took part in a unit on transportation that integrated dance movements. The control group studied the same content, but without dance integration.</p>	<p>The term 'experiment' is used but there is no mention of randomisation; quasi-experiment (researcher-designed tests on transportation and dance concepts - multiple-choice/short answer/matching/true-false; journal entries)</p>	<p>Fifth graders (N=40); n=18 control, n=22 experimental</p>	<p>The broad concept of arts integration underpins this study. The author uses the term 'interdisciplinary' to describe the integration of dance with other subjects. The work of Overby, Post and Newman (2005) is regularly cited ("Interdisciplinary learning through dance: 101 moventures")</p>	<p>Quantitative data: There was a significant increase in knowledge of transportation scores in the experimental group ($p < 0.0001$); this was not the case for the control group. There was a significant difference in post-test transportation scores between the experimental and control group ($p = 0.021$). There was no increase in scores on the movement test from pre to post (this test was only taken by the experimental group). Qualitative data: The experimental group produced more affective responses in journals than the control group (49 affective v 10 affective). 80% of affective responses were positive in the experimental group. The experimental group also produced more psychomotor responses (53 v 0). Some negative responses to dance-integration were reported.</p>	<p>(i) Statistical analysis does not account for multiple comparisons - other statistical tests may have been more appropriate, (ii) the use of intact groups is not given appropriate weight in consideration of the results, (iii) same test taken before/after intervention, (iv) some measures only taken by the experimental group, (v) non-conventional reporting of inferential test results, (vi) small sample size</p>	<p>Journal Article (Peer Reviewed)</p>



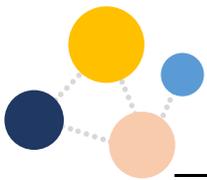
<p>Landley (2017) United States</p>	<p>This study examined teacher experiences of arts-integrated professional development programmes conducted in specific school settings (Higher Order Thinking [HOT] Schools). HOT schools were established in one US state (Connecticut) in 1994 with the aim of inspiring 'lifelong learning in, about, and through the arts in a democratic community celebrating each child's unique voice' (Koba, 2015a, p. 2). These philosophical ideas underpinning these schools were derived from the work of Bloom (1995), Renzulli (2014), Dewey (1916), and Gardner (1983). In schools that have implemented the HOT approach, the arts disciplines were taught as rigorous academic subjects and integrated with other subjects across the curriculum</p>	<p>Case Study (Questionnaires, Interviews, Observations)</p>	<p>In-Service Teachers/PD Participants (N=24)</p>	<p>The author uses this definition of Arts Integration: "...the investigation of curricular content through artistic explorations... the arts provide an avenue for rigorous investigation, representation, expression, and reflection of both curricular content and the art form itself" (Donovan & Pascale, 2004, p. 14). The author spends some time discussing Bresler's (1995) styles of AI as a way of understanding the use of resources, pedagogies of arts instruction and curricular structures in relation to and within the overall school curriculum. They also highlight Eisner's (2002) 4 typical curricular structures of AI (historical/cultural, within the arts, other subjects, problem-solving)</p>	<p>Teachers reported professional growth and described how HOT AI PD had transformed their teaching practice. This was accomplished through experiential and ongoing PD that teachers found relevant to their teaching. 'Emergent' themes were related to teacher benefits, student benefits, PD strategies, and community. Teachers expressed satisfaction with hands-on PD strategies focused on student-centered learning, with emphasis on process rather than product, encouraging deep learning through the arts. Participants' narratives highlighted the effectiveness of PD strategies utilizing teachers as instructors for their peers, and collaborative residencies with professional teaching artists in the schools. Teachers enjoyed enhanced collegiality resulting from collaborative work when creating arts-integrated curricula, and arts specialists teachers appreciated the respect they received from classroom teachers who recognized the value of the arts as modes of inquiry. Teachers demonstrated enthusiasm for the program.</p>	<p>(i) limited range of data, (ii) generalisability (highly specific school system - employs arts specialist and generalist teachers to support a rigorous, discipline specific curriculum alongside an integrated approach, difficult to discern 'who said what' in the data analysed), (iii) poor response rate for questionnaires, (iv) role of researcher in the study was unknown i.e. potential relationship with HOT/participants etc.</p>	<p>Doctoral Thesis</p>
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<p>Lara (2017) United States</p>	<p>This study examined the efforts of one Californian elementary school in developing, implementing, and sustaining an arts integrated curriculum with a particular focus on the role of student culture in arts-integrated lessons.</p>	<p>Case Study (Interviews, Observations, Artefacts [Lesson Plans, Institutional Documents])</p>	<p>In-Service Teachers/Administrators at the same elementary school (N=10; 6 teachers, a teaching artist, 2 teachers on special assignment (TOSAs), and the principal)</p>	<p>The author uses the Kennedy Center's definition of arts-integration, stating that it is an 'approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both' (See p. 4). While no particular framework or model to summarise a curricular based approach to arts education is provided, the author does use Eisner's (1998) three-tier framework to help define the outcomes of arts education (arts-based outcomes, arts-related outcomes, ancillary outcomes [e.g. culture]).</p>	<p>Key themes were constructed from the data analysis: a) relationship between CCSS and arts integration (participants indicated that the relationship between CCSS and arts integration was one-way - arts supported mastery in CCSS objectives but CCSS did not support the arts in mastery of anything), (ii) essential structures in developing, implementing, and sustaining an arts integrated curriculum (teachers' comfort with arts, time to teach AI lessons, fear of losing funding), (iii) arts integration as student centred and disruptive education (all participants agreed that AI supported collaboration, self-expressions and self-exploration) and (iv) arts integration as cultural wealth (AI empowered students to take control of their learning, inspired respect for their peers, and instilled confidence. However, students' cultural wealth was not present in AI lessons, even though there was evidence of it school-wide).</p>	<p>(i) generalisability (specific context), (ii) limited range of data gathered, (iii) short time frame, (iv) sampling bias (self-selection)</p>	<p>Doctoral Thesis</p>
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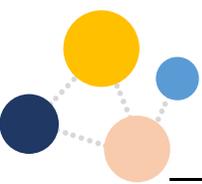


<p>Lasen (2017) Australia</p>	<p>In this study, pre-service teachers interviewed co-operating teachers about their perceptions of Education for Sustainability as a cross-curricular priority.</p>	<p>Case study (interviews)</p>	<p>In-service teachers (N=43) from a variety of schools, interviewed by pre-service teachers (n=43) placed in their classrooms</p>	<p>No model of integration is cited; the context for this study is the Australian cross-curricular priority (EfS).</p>	<p>(i) Teachers perceived EfS to be a relevant cross-curriculum priority; their perceptions spanned different attributes of EfS (e.g. EfS as relevant, values orientated, holistic, action orientated, issues-based), (ii) A small number (n=8, 18.5%) of teachers indicated that they were not integrating sustainability due to other competing demands (e.g. literacy); two teachers referred to incidental teaching but the majority (n=27, 63%) intentionally planned their EfS instruction; it was most regularly integrated with science with limited integration with history, mathematics, religion and technology, (iii) The largest barrier to implementation was 'lack of time/crowded national curriculum', noted by n=23 teachers; substantial time was allocated to English/maths; another barrier was a lack of teacher content and pedagogical knowledge, linked with a lack of PD; a third of teachers expressed concerns about children's ability to address EfS concerns, linked with barriers in particular school communities (e.g. parents' values/habits)</p>	<p>(i) Researchers did not carry out interviews - novice interviewers, (ii) reliance on self-report</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Lau (2018) Hong Kong</p>	<p>This instrumental case study examined how a kindergarten teacher attempted to integrate other subjects into the music curriculum.</p>	<p>Case Study (Observations, Interview, Artefacts)</p>	<p>In-Service Teacher (N=1)</p>	<p>The author notes the key role curricular integration has in their country's curricular documents i.e., teachers in Hong Kong are encouraged to recognize and leverage the links between various disciplines, to 'incorporate play activities into different learning areas and plan the curriculum through an integrated approach' (p. 41). More in-depth discussions surrounding conceptualisations of CI etc., are not included in the Lit Review of this paper.</p>	<p>Findings show that the teacher became more confident in implementing music-integrated instruction and that the support of the principal was pivotal.</p>	<p>(i) potential sampling bias, (ii) generalisability (highly specific context), (iii) limited range of data gathered,</p>	<p>Journal Article (Peer Reviewed)</p>

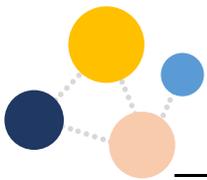


Leckie (2016) United States	The literacy integration practices of three pre-service middle school teachers were analysed, drawing on the preparation of an integrated literacy/social studies unit taught on school placement.	Collective Case Study (coursework completed by students;	Pre-service middle school teachers (N=3)	Disciplinary literacy is the primary conceptualisation of integration offered in this study; student teachers were encouraged to integrate literacy into their social studies teaching and vice versa. This was framed within a broader goal of having curricular integration at the middle school level.	Two main findings are reported: (i) student teachers engaged in very brief, teacher-directed literacy integration tasks that were often given short shrift if time was as an issue; this pieces often lacked an authentic purpose; writing, listening and speaking were less well-represented than reading, (ii) when student teachers were given advice on including more complex literacy tasks by supervisors, they tried them out. The authors conclude that early 'field experiences' (school placement) is important for students to gain experience, with feedback, on their practice.	(i) Small sample size, (ii) relationship between university tutors and the subjects of the study, (iii) no outcome measures from children	Journal Article (Peer Reviewed)
Lee (2018) Republic of Korea	This study sought to develop a scale (Elementary School Teachers' Environmental Pedagogical Content Knowledge) to assess the knowledge needed for teaching environmental education. The product is a 63-item questionnaire, with 39 items relating directly to ePCK and its subscales. The scale was subsequently used to assess the effectiveness of a PD program on this subject matter.	Study 1: Scale validation; Study 2: Survey (using scale)	N=130; n=44 participants on a graduate environmental education program, compared with n=86 non-participants	Environmental education is not a discrete subject at elementary level in Korea, thus 'permeative instruction' is used to embed it in a multidisciplinary manner. The conceptual framing of the study, however, is focussed almost entirely on environmental education rather than integration.	Following development of the scale, it was used to examine difference in ePCK between participants and non-participants on a graduate level environmental education program. There was a significant difference in all subscales of the ePCK, with EE program participants scoring higher. Scores on individual items relating to the interdisciplinary and multidisciplinary nature of EE and cross-curricular approaches differed significantly, with a large effect size. Further comparisons between groups are also reported (but not relevant for the current review). The authors conclude that specific PD on EE is warranted and that further research is needed on how EE is embedded across multiple content areas.	(i) Limited focus on integration, (ii) highly particular context that may not be generalisable	Journal Article (Peer Reviewed)
Lehrer (2021) United States	This study examined 1st and 2nd graders experiences in and integrated science/maths unit involving prairie plants. The study paid particular attention to those STEM guidelines that may need to be ignored or modified by teachers to ensure effective instructional design.	Case Study (Observations)	One 1st/2nd Grade Classroom (n=18 students with n=1 teacher)	The authors offer a brief summary of the potential 'pros and cons' of integrated STEM activities, with particular reference to Science and Maths. They noted two particular approaches regarding the integration of Maths and Science: (1) as students recruit mathematical resources to develop, test, and revise models of the natural world, and (2) as	It was somewhat difficult for the learners to generalise what they had learned in Maths class to the 'real world' (which was more unfamiliar). Some problems appeared to stem from the authenticity of some tasks (e.g. representing the prairie in map form). Furthermore, some of the tasks/discussions inspired solutions that disrupted the teacher's mathematical agenda (e.g. difficulties the children had in coming to a consensus about what units of measurement to use). To	(i) generalisability (e.g. size, context), (ii) analysis procedures needed more description, (iii) limited range of data gathered	Journal Article (Peer Reviewed)

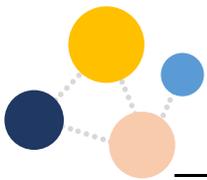




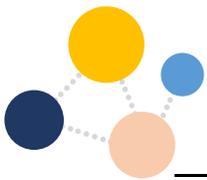
				they construct and structure data to develop empirical conclusions as products of inquiry	promote STEM education, educators need to be aware of the task solutions that children are likely to invent, thoroughly address children's understanding of representational conventions, and select tasks in which model-test and revision play a prominent role. The authors argue that empirical research needs to be conducted to inform us about how problems can be posed in ways that reliably evoke variable solutions that can be capitalized upon to make progress within the target disciplinary frame		
Leszczynski (2014) United States	This study examined the nature of mathematics and science connections made by sixth and seventh grade mathematics and science teachers in their classrooms in one middle school.	Case Study (Survey [Program-Specific Attitudinal Teacher Survey], Interviews, Observations)	In-Service Teachers (N=4; 2 science teachers, 2 maths teachers)	The author spends some time comparing and contrasted integrated and interdisciplinary teaching approaches. Integrated instructions of maths and science was defined as an explicit assimilation of maths and science concepts with equal attention afforded to each discipline with the boundaries between them remaining 'indistinguishable'. They defined 'interdisciplinary teaching' as those instances where the focus of instruction is on one discipline with the other discipline 'supporting' the first. Connections between maths and science (the disciplines of interest in this study) are implicit. The author also offered an examination of two models of integration: Continuum Models (e.g. Hurley, 1998; sequential, partial, enhanced, and total integration) and the BWIAM (Berlin-White Integrated Science and Mathematics) Model for Integration of Mathematics and Science which involved 6 aspects of science and mathematics integration (ways	Teacher practices in making mathematics and science connections in the classroom incorporated many of the characteristics of integrated instruction presented in the literature e.g. maths used as a tool for science or vice versa. Science teachers tended to focus on the application of mathematical procedures in their lessons. Teacher attitudes toward integration were found to be generally positive and supportive of integrated instruction. According to the author, mathematics teachers shared a common perception of integration being two separate lessons taught together in one lesson. In contrast, science teachers perceived integration to be a seamless blend of the two disciplines. The researcher related these perceptions and attitudes to the teachers' past experiences with mathematics and science connections and integration, and also to their practices of mathematics and science connections in the study with the graduate students.	(i) highly specific context (see 'Teacher Role'), (ii) limited data gathered (e.g. only the teachers were involved in this study - not the graduate students that they worked with), (iii) sampling issues (self-selection of sample, size)	Doctoral Thesis



				of learning, ways of knowing, process and thinking skills, content knowledge, attitudes and perceptions, and teaching strategies)			
Levy (2018) United States	This study examined the impact of a scientist-elementary school teacher partnership on student learning in science and engineering. A practicing scientist mentored a 6th grade elementary science teacher and supported their participation in professional development activities, use of appropriate science/engineering teaching strategies etc. This study also evaluated the impact of this partnership on student learning.	Mixed-Methods Case Study (Researcher Design Surveys, Observations, Interviews Artefacts [lesson plans], Pre-Post Data from Students [drawings, reflections, student work samples])	In-Service Teacher (n=1) working with a practicing scientist in their two 6th Grade science classes (n=56)	No in-depth discussion on the theoretical foundations of integrated Science and Engineering integration was provided. Reference was very briefly made to Bybee's (2014) work on the challenges surrounding interdisciplinary work involving Science and Engineering .	The intensive, long-term scientist-teacher partnership that formed the basis of the professional development programme involved in this study had (what the author called) a positive impact on the teacher's practice, particularly in relation to her classroom practice and the role of experiential learning experiences within it. The author noted that the teacher was more confident in implementing different instructional practices e.g. make explicit connections between natural water filtration and classroom models, integrated approach to discuss engineering and filter design. The scientist-teacher mentorship resulted in an increase in the teacher's confidence and ability to teach elementary science topics (on water science) and to modify resources to better suit her and her classroom's needs. Students' conceptual understanding of water cycle components and processes progressed over the course of the unit. Based on the author's analysis of the gathered qualitative and quantitative data, students were able to understand systems thinking and developed dynamic thinking. Quantitative results indicated that pre- and post-test scores were low across both classes, but all students had improved their test scores after participating in the unit	(i) generalisability (teacher was a science specialist rather than a generalist elementary school teacher, sample size), (ii) researcher designed PD materials, (iii) novel effect (on student learning),	Doctoral Thesis

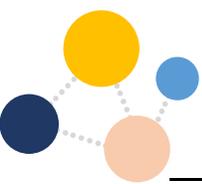


<p>Liston (2018) Ireland</p>	<p>In this study, the researchers co-taught science lessons that were inspired by the storybook 'We're Going on a Bear Hunt'. Literacy strategies were embedded within each of the phases of the science inquiry cycle, the focus of which was layered on topics relevant to the theme of the book. The authors highlight synergies between literacy and science teaching.</p>	<p>No specific design mentioned; qualitative (researcher-designed questionnaires pre and post with children; interviews with teachers)</p>	<p>Children (N=48) from primary schools (n=2)</p>	<p>Underlying conceptual similarities between science and literacy skills served as the foundation for the integration undertaken in this project. Literacy activities were embedded within each stage of the 5 E science cycle (engage, explore, explain, elaborate, evaluate).</p>	<p>All 48 children reported enjoying science lessons integrated with storybooks; all agreed that this was a 'good idea'; students were better prepared to plan investigations based on storybooks after the intervention. Teachers reported that the literacy practice employed engaged children at a deeper level with aspects of the science inquiry cycle.</p>	<p>(i) Researchers were heavily involved in the implementation of teaching, (ii) no outcome measures, (iii) overall methodology would benefit from clearer framing and collection of broader data</p>	<p>Journal Article (Peer Reviewed)</p>
<p>López-Leivaa (2016) United States</p>	<p>This study describes the implementation of an integrated unit of work about motion that taught science, technology and maths concepts to a class of sixth graders in the United States. The unit was collaboratively designed (and implemented) by the group's teacher and two members of a local university faculty.</p>	<p>Action Research (Observations, Work Samples from students; Teacher Reflective Journal)</p>	<p>Sixth-grade students (N=16), their class teacher (n=1) and university faculty members (n=2)</p>	<p>The authors offer this definition of STEM education: "an interdisciplinary approach to learning that removes the traditional barriers separating the disciplines of science, technology, engineering, and mathematics and integrates them into real-world, rigorous, and relevant learning experiences for students" (Vasquez, Sneider, & Comer, 2013, p. 4). No particular model of integration is invoked but the authors view their approach to integration as being one that it informed by a strong socio-cultural perspective.</p>	<p>The authors summarised the key features of their learning model under 5 headings ('MESSY'): Movement, Engagement, Social Interactions, Spontaneity, and 'Yikes and Yippees'. The authors argued that the design of the learning activities according to the guiding principles of these headings (where the final one refers to the moments of confusion and mistakes that support deeper understandings of concepts) allowed students to better understand the scientific concepts being examined (motion).</p>	<p>(i) small sample size, (ii) insufficient data gathered to support any reliable inferences on student learning, (iii) selection bias (teacher self-selected for involvement in the research as they were interested in STEM), (iv) unclear methodology</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Lorger (2019) Croatia</p>	<p>This study examined how Croatian geography and PE teachers integrated orienteering in a cross-curricular manner. Researchers surveyed a mixture of geography/PE teachers from both primary and post-primary schools. Orienteering is not formally on the school curriculum in Croatia.</p>	<p>Survey (researcher-designed questionnaire on orienteering practices)</p>	<p>N=146 teachers; 109 Geography teachers and 37 PE teachers; a majority of both were from primary schools</p>	<p>No specific model of integration is cited. The authors refer to the potential for orienteering to cross both the geography and PE curriculum. They focus on the potential for orienteering more so than the potential for integration.</p>	<p>A range of patterns in the survey data are reported, though few are directly relevant for the current review. Few schools taught orienteering either in an extracurricular manner or as part of a school subject. There were few differences between how PE and geography teachers responded. Orienteering was statistically more likely to happen in primary schools (p=0.02). The authors use the results to claim that orienteering should have a firmer place in the Croatian school curriculum.</p>	<p>(i) Very specific context that likely does not generalise</p>	<p>Journal Article (Peer Reviewed)</p>



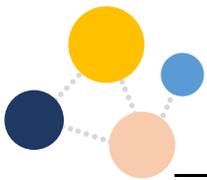
Lovemore (2021) South Africa	This action research study shares the outcomes derived from a series of ten lessons in which aspects of music notation were integrated into the teaching of fractions in a Grade 5 classroom in South Africa.	Action Research (Reflective Journals, Lesson Recordings/ Observations, Work Samples, Student Feedback)	Grade 5 Students (N=16)	The author cited Bresler's (1995) styles of arts integration as the theoretical foundation for the study. Bresler (1995) identified four approaches to arts-integration: the subservient approach, the affective style, the social integration style and the co-equal, cognitive style. The author located her research within the 'co-equal, cognitive style' (whereby learning from art forms and other subjects are of equal importance).	The author identified a number of ways/learning activities in which note values can be implicitly and explicitly linked with key fraction concepts (e.g. paper plates activity, fraction line vs note value line) to enhance understanding among learners. The author noted that it was 'challenging' to achieve a co-equal style of arts integration, whereby one subject was not subservient to another. It was not until the final lessons did the author (and her critical friends) believe that this had been achieved. The author also identified the following benefits of CI in her study: real-life problem solving opportunities, confidence, multiple representations and hands-on practical opportunities, motivation and active involvement, collaborative opportunities amongst teachers and learners.	(i) researcher effects, (ii) no outcome measures from children	Journal Article (Peer Reviewed)
Luna (2015) United States	In the context of the school garden, two second-grade teachers introduced children to homonyms, linking science and literacy. This study examines the impact on student homonym knowledge.	Pre-post no control (researcher-designed measure of student homonym knowledge and application)	Second grade teachers (N=2)	Cites Czerniak (2007) to refer to integration as "connecting two or more disciplines with the intention to enhance learning". The study draws on the broad literature on science/literacy integration but is instanced in a garden-based learning (GBL) context.	Statistically significant improvement in homonym knowledge in the short term (2 weeks) and long term (7 months); ANOVA (n =43, F = 157.695, p <.001)	(i) No comparison/control group, (ii) small sample size, (iii) researcher-designed measure, (iv) very particular instantiation of integration, (v) not clear that it was the *garden* context that made a specific contribution to the growth in homonym knowledge	Journal Article (Peer Reviewed)
Luo (2022) United States	This study examined elementary students' understanding of variables having received instruction using a maths-computational thinking integrated approach.	Mixed Methods (Mid-Post Intervention Data Gathered; Cognitive Think-Alouds)	4th Grade Learners (N=36; Cognitive Think-Alouds, n=9)	No discussions on curricular integration were included in this paper.	Analysis of both the quantitative and qualitative data gathered indicated that students lacked a conceptual understanding of using variables to create generalized problem solutions that could work with any set of inputs. Students also had difficulty with specific mechanics of using variables e.g. updating variable values.	(i) high attrition from mid- to post-intervention, (ii) unclear who delivered instruction to the students (i.e. researchers or teachers), (iii) analysis of quantitative data was short and was	Conference Proceedings/ Papers



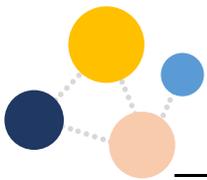


inadequately described, (iv) insufficient discussions on the maths-CT integrated lessons

Magdaş (2017) Romania	This study examines teachers' perceptions of the subjects 'Mathematics and Environmental Exploration' (MEE), which was newly introduced to the Romanian curriculum in 2012.	Survey (researcher-designed questionnaire)	Teachers (N=131)	Integration, as a concept, is not specifically addressed in this paper.	A variety of findings are reported regarding teacher perceptions of the materials available to enact the MEE curriculum, though not all are relevant for the current review. Teachers were more likely to use online sources and online fora to support their teaching of the MEE subject, followed by methodological guides, mathematics education books, the school curriculum and other official documents. They were least likely to draw on geography education textbooks. Teachers were roughly evenly split on how helpful they found the available textbook, with roughly half finding them useful and half finding them not useful. Teacher views were mixed on how helpful the MEE textbooks were for supporting children's knowledge of mathematics and environmental education in daily contexts. Teachers reported that the biggest benefit of MEE was it motivates children's learning. In terms of limitations in enacting MEE, the largest reported was a lack of support materials.	(i) Limited description of the development of the questionnaire instrument, (ii) some linguistic/grammatical issues in presentation of the article, (iii) lack of contextual information to fully ground the findings	Journal Article (Peer Reviewed)
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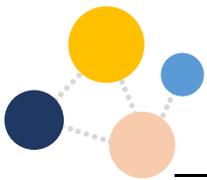


<p>Maitles (2012) Great Britain</p>	<p>This study focuses on the teaching of a topic ('the zoo') to early primary (5/6) children, drawing on cross-curricular and active learning approaches. Children and parents' views on the unit are sought through questionnaires, observations and focus group interviews. Limited attention is given to the conceptualisation or practicalities of integration in the study; it focuses more so on active learning.</p>	<p>Action research (focus groups with children; parent questionnaire; structured observations)</p>	<p>Early primary teacher (n=1) and her students (n=30); Parents (n=20) also responded to questionnaire.</p>	<p>Integration in this study is framed within the broad context of Scotland's Curriculum for Excellence. Integration is not specifically defined or conceptualised; the study focuses more so on 'active learning'</p>	<p>(i) Parents were supportive of this form of teaching and noted that supported engagement and supported links beyond the classroom, (ii) more than 78% of children were engaged in their learning during observations; engagement was less likely during difficult activities or activities deemed less interesting, (iii) children were very positive about the learning experiences provided (relating to the zoo)</p>	<p>(i) Small in scale, (ii) teacher evaluating their own practice, (iii) lack of detail in how subjects were addressed, (iv) potential for biased responses/power dynamics in student contributions</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Makopoulou (2020) Great Britain</p>	<p>This study relies on the premise that integrating dance (as a form of physical activity) into reading lessons will support children's reading comprehension. Embodied cognition may support deeper understanding and recall. Students in the intervention group took part in dance-integrated lessons that involved dance-based responses to text.</p>	<p>Pre/post including a control, using intact groups (test of reading comprehension - provenance unspecified; pupil questionnaire - researcher designed; focus groups with pupils)</p>	<p>Year 4 students (N=42); n=24 in the dance intervention; n=18 in the control</p>	<p>Dance was integrated into lessons focussing on reading comprehension, e.g., students performed a dance in response to sentences from a text. No specific model of integration is invoked.</p>	<p>Quantitative data suggest that reading comprehension improved in the dance-integrated group; linear mixed model results indicated a moderate effect size. Qualitative data indicated that overall, students were able to pinpoint aspects of new learning from the intervention. Not all students agreed that the dance-integration benefited their reading ability. Most (80%) students enjoyed the dance-integrated lessons.</p>	<p>(i) Use of intact rather than randomised groups, (ii) lack of detail on the measures used (reading comprehension in particular), (iii) short duration of the intervention (8 lessons), (iv) the control group took part in regular PE lessons and thus had less exposure to text</p>	<p>Journal Article (Peer Reviewed)</p>



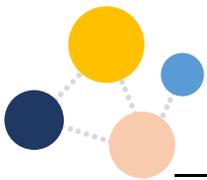
Mard (2022) Finland	This study draws on General Didactics principles (attributed to Wolfgang Klafki and Wolfgang Schulz) to examine how multidisciplinary teaching is enacted in two case study schools. In case one, entrepreneurship was developed over a week-long module integrating multiple subjects (social studies, visual arts, Swedish, literature, home economics, mathematics); case two examines an eight-week module on the renaissance, integrating history, RE, visual arts, Swedish and literature. The authors propose a model for multidisciplinary teaching.	Case study (interviews, observations)	Finnish primary schools (N=2)	The term multidisciplinary education is used "when referring to all forms of education in which two or more subjects are connected" (p. 244). Citing the work of Nollmeyer et al (2016), two key principles are outlined: (i) connections between disciplinary content and skills and (ii) meaningful and student-centred collaborative experiences. The didactic models of Wolfgang Klafki and Wolfgang Schulz provide a key theoretical basis for the study.	(i) sociocultural factors and the school culture affected multidisciplinary teaching, with student needs/interests influencing instruction, (ii) one week per year in case one was spent on interdisciplinary teaching, with each grade level deciding its own focus - this allowed the multidisciplinary teaching to fit within the subject-based school curriculum; in case two, the multidisciplinary teaching was folded into regular units which addressed themes/subjects (one of four such units in the year), (iii) In case one, transversal competences were set for the multidisciplinary module, rather than having subject-based competences (though they still drew on perspectives from various subjects); in case two, subject-specific competences were built in to the Renaissance unit, (iv) Themes were chosen with reference to those deemed important for students, (v) There was variety in the methods of pedagogy/assessment used, each aligned with the multidisciplinary theme. The authors propose a model of multidisciplinary teaching that draws on the General Didactic principles of Klafki and Schulz.	(i) Limited contextual information provided for the sample/cases, (ii) relatively limited information provided on how data were collected, (iii) small sample/case size	Journal Article (Peer Reviewed)
Marshall (2018) United States	The researcher worked with six fourth grade teachers in her own school to investigate science-literacy integration practices. The study draws on Stringer's (2014) model of action research (look-think-act).	Action research (interviews, observations, pre/post-tests, reflections)	Fourth grade teachers (N=6)	Integration is defined as "an instructional strategy wherein content areas are taught simultaneously" p.5), citing McQuitty (2016). The broad literature on science and literacy integration frames the study (e.g. Cervetti et al., 2012)	(i) Perceptions/instruction at the outset: The subject of science was under time-tabling pressure, often being replaced with maths due to 'low scores' in the latter subjects in the preceding year; at the outset of the study teachers taught subject areas in isolated blocks; teachers used state standards to plan instruction, (ii) Transformation after study: teachers moved to integrate ELA and science time rather than teaching them separately; teachers began to make connections between the state standards for ELA and science, (iii) post-test scores were higher in each classroom (note limitations)	(i) Un-piloted researcher-constructed pre/post-tests, (ii) same test used pre/post - practice effects, (iii) limited analysis completed on test scores (just reporting means for each class), (iv) potential researcher effects/social desirability when working with colleague	Doctoral Thesis



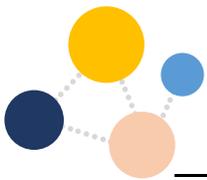


<p>Martin (2021) United States</p>	<p>In this study, the disciplinary literacy practice of four first grade teachers was observed and analysed. Coding revealed the types of practices that supported and inhibited the development of disciplinary literacy across various subjects.</p>	<p>Collective case study; four elementary schools (classroom observations; field notes; audio recordings)</p>	<p>Elementary teachers (first grade) (N=4)</p>	<p>Literacy-content area integration is framed using a disciplinary literacy lens.</p>	<p>First grade teachers engaged in a range of teaching approaches that supported the development of disciplinary literacy. The researchers also noted what they refer to as 'problematic' instances of disciplinary literacy, (i) not linking first-hand experience with disciplinary literacy (ii) limiting disciplinary literacy learning by focusing on word and world knowledge without focusing on the construction of knowledge (iii) neglecting to consider the perspectives offered by alternative texts.</p>	<p>(i) Limited sample, (ii) the framework for analysis may have overly privileged disciplinary literacy models (as opposed to basic/intermediate literacy, given the age level involved)</p>	<p>Journal Article (Peer Reviewed)</p>
<p>McDowall (2019) New Zealand</p>	<p>This report presents the findings from a research project on curriculum integration in New Zealand schools, carried out by NZCER in 2018–19. The purpose of the research was to explore teachers' rationales for curriculum integration; the approaches and practices used to integrate curriculum; and the learning opportunities such approaches provide for students.</p>	<p>Qualitative (Survey [NZCER 2018 National Survey of Secondary School Principals and Teachers], Focus Groups/Mediated Conversations)</p>	<p>In-Service Teachers (Survey: n=167 principals, n=705 teachers; Workshops: Primary: n=8, Secondary/Junior High: n=15)</p>	<p>No model of integration is provided to explain the theoretical assumptions underpinning NZ's approach.</p>	<p>Key Findings: Over half of secondary schools integrate curriculum at some level and over two-thirds of principals (76%) and teachers (68%) rated their experiences with integration as successful or very successful. Under three-quarters of the teachers indicated that when teaching using an integrated approach they found it: easier to explore authentic issues and contexts (74%); more stimulating to work with another teacher (72%); or more engaging for them as a teacher (68%). A sizeable minority agreed or strongly agreed that: an integrated course is more work to teach (43%); it is more difficult to cover each subject in depth (42%); integration caused timetabling difficulties in their school (38%); it is more difficult to align an integrated course with the National Certificates of Educational Achievement (NCEA) (38%); and that such courses are more work to assess (36%). 70% of teachers said they had not experienced curriculum integration in the past 3 years. The two reasons most frequently identified by principals were that it is too hard to timetable, and that subject coverage would be too superficial. The two reasons most frequently identified by teachers for not integrating were concern about depth of subject coverage, and the perception that school leaders would not</p>	<p>(i) teachers from both primary and secondary contexts involved in the study - difficult to 'disentangle' the two, (ii) Details on qualitative data analysis undertaken is sparse, (iii) details on the curricular frameworks that should inform teacher use of CI in classrooms is notably lacking</p>	<p>Reports</p>



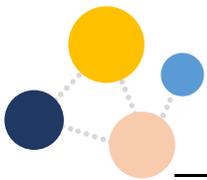


					support integration. The main reasons the workshop teachers gave for integrating curriculum were to: provide students with opportunities to explore relevant and authentic issues, enhance opportunities for all students to achieve' provide opportunities for students to develop capabilities for 21st century learning, provide opportunities for students to "see connections" and "go deeper" and, enable more efficient curriculum delivery and use of time. The most frequently integrated learning areas were English, the arts, and the social sciences. The least frequently integrated was maths, followed by science. Reasons for not integrating maths and science usually related to the hierarchical nature of the knowledge development in these areas and the need to teach concepts in a certain order.		
McFadden (2017) United States	This study examined the activities of two teacher design teams (TDTs) during a professional development experience centred on STEM-integrated curriculum development. The study aimed to understand how teachers engaged with the complexities of integration.	Case Study (Observations)	In-Service Teachers (N=3)	No discussions on curricular integration beyond a statement that STEM required an interdisciplinary approach was presented.	Results showed that when a TDT is not prompted and enabled to first articulate and negotiate the overall value of a STEM-integrated curriculum, they will then follow their intuitions as classroom teachers and engage in the process. However, 'they will inevitably apply familiar strategies and shortcuts in order to accomplish the task in the time allotted even if it is not how "experts" would do it (p. 18). Second, involving practicing teachers in the curriculum design process requires complete "participation" with the curriculum ideas they are contemplating.	(i) small sample size, (ii) limited range of data	Journal Article (Peer Reviewed)



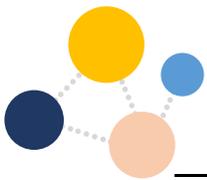
Mildenhall (2021) Australia	This study reports the implementation of a STEM unit of work based on the plight of the honeybees as experienced by two primary school teachers and their classes. After completing some form of professional learning, the two teachers involved elected to work together to team-teach the 'Honeybee' STEM module to their two classes (60 learners in total) over a series of 8 lessons.	Case Study (Interviews; Videoed lesson observations; work samples)	In-Service Teachers (n=2), Children (N=60)	No model of integration is specifically discussed. The authors offer a definition of STEM instead using the term 'interdisciplinary' as part of this definition.	According to the authors, the data gathered indicated that this extended, integrated learning module was able to support the development of student understanding of the plight of honey bees. Children were able to demonstrate their learning by creating board games and bee hotels.	(i) Researcher bias (involved in classroom activities etc.), (ii) Hawthorne Effect, (iii) no discussion on possible confounders e.g. class size (iv) self-selection bias (teachers were very committed to STEM education)	Journal Article (Peer Reviewed)
Miller (2019) Australia	This study examined how mathematical knowledge and thinking, specifically the identification of mathematical patterns and structures can be promoted through engagement with coding lessons involving a visual programming language ('Scratch').	Teaching Experiment Methodology (Pre-Post Test Data [researcher-designed assessment] with a control group, observation data)	Year 2 Learners (N=135; with n=40 involved in a teaching experiment, n=95 as a control)	No particular model or definition of STEM curricula was provided in this study.	Both the control and treatment groups exhibited a significant increase between pre- and post-test scores with regards to their understanding of mathematical patterning. However, the intervention group performed much better (M: 16:30) than the control group (M: 11.95). Analysis of the qualitative data indicated that the students involved in the intervention group developed a strong conceptual understanding of pattern and were able to apply it to other, related mathematical concepts e.g. algebra.	(i) researcher delivered the intervention, (ii) inequivalent sample sizes for control and treatment group, (iii) activities of the control group were somewhat unclear,	Journal Article (Peer Reviewed)
Miller-Ray (2019) United States	This study examined the impact of a professional development program on teacher attitudes and confidence levels toward the use of STEM and instructional technology in their elementary and middle school classrooms.	Intervention (Pre-Post data gathered using modified versions of the STEM Semantics Survey [SSS], Teachers' Attitudes towards Informational Technology (TAT), Technology Proficiency Self-Assessment for 21st Century Learning (TPSA-21), Stages of Adoption of Technology)	In-Service Teachers (N=57)	No discussions on the theoretical foundations for STEM integration were provided.	Participants reported a statistically significant increases in self-reported competence in technology integration, confidence levels toward integrating World Wide Web, emerging technologies for student learning, teacher professional development, and attitudes toward math, technology, science, and STEM careers. A small gender bias was noted i.e. females seemed more likely to demonstrate increases in scores for these areas	(i) large funding source for PD programme (sustainability, generalisability), ii) sample size, (iii) self-report measures	Book Chapter (Edited Book)





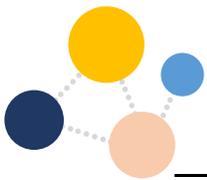
<p>Monteiro (2021) Portugal</p>	<p>This study examines how pre-school/primary teachers embedded coding (plugged and unplugged) across learning activities and curricular areas. Following participation in a 50-hour PD course, teachers participated in a case study in which they logged their practice and partook in lesson observations. These data were analysed to determine patterns in how coding/computational thinking activities were embedded in a cross-curricular manner.</p>	<p>Multiple case study (activity logs; field notes; photos; video recordings; field observations using an engagement checklist)</p>	<p>Educators (N=28); 17 primary and 11 preschool; this study focuses on preschool experiences</p>	<p>The authors claim that coding must be integrated with learning in the curriculum if it is to be meaningful socially and culturally; it necessarily 'cuts across disciplines'. No specific model is endorsed. The terms interdisciplinary, transversality and multidisciplinary are used with significant definition or conceptualisation.</p>	<p>In practice, computational thinking was embedded across a range of curricular content areas, including 'expression and communication', 'world knowledge', 'personal and social development' and multidisciplinary instances. They highlight that 'expression and communication' serves as a particularly fruitful curricular area for developing computational approaches. The authors conclude that computation can be integrated seamlessly across learning activities at pre-school level.</p>	<p>(i) Delays with observation due to the pandemic, (ii) difficulty in replicability (high level of support offered), (iii) no measurement of learner outcomes</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Moss (2019) Australia</p>	<p>This research employs case study methods to examine how two schools that had engaged with integrated curriculum period over a sustained period. Data were gathered over two school terms with one class in each school. The researchers offer a number of observations on the challenges of planning integrated instruction and assessment.</p>	<p>Case study (classroom observations; interviews; focus groups)</p>	<p>Schools (N=2); year 1 class in school 1 (n=26); year 7 class in school 2 (n=23)</p>	<p>A range of models of multi-/inter-/trans-disciplinary integration are discussed in the literature review.</p>	<p>(i) In the primary case school, three hours per week were allocated to integrated curriculum units, with a full day's planning for teachers once per term; an integrated unit on 'celebrations' was supported by a 24 page unit document that was planned using a commercially available electronic unit planner; learning outcomes and assessment in line with the state curriculum were linked with the inquiry focus and learning experiences were subsequently planned (backward design); no formal approaches to integrated planning were yet evident in the secondary school, (ii) Disciplines contributed to developing general capabilities in different ways; students at both primary and secondary were able to articulate how multiple subjects contributed to cross-curricular learning, which they saw as beneficial, (iii) A variety of assessment strategies were used across the schools (rubrics/peer-assessment/self-assessment); these assessments were planned at the outset of integrated units, (iv) researchers conclude that a transdisciplinary approach was in use in the primary school, adopting a clear conceptual framework; the secondary school's approach was classed as</p>	<p>(i) Small sample size, (ii) lack of objective outcome measures</p>	<p>Journal Article (Peer Reviewed)</p>





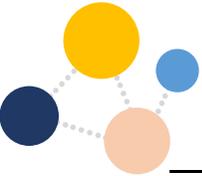
					multidisciplinary (without a clear conceptual framework or clear problem/issue)		
Nadelson (2012) United States	The authors organised a four-day residential summer institute (i-STEM Summer Institute) for 230 Grade 4-9 teachers. This intense form of professional development involved: 32 hours of instruction (e.g., field trips, plenary lectures, panels, content-specific instruction related to key themes like 'space' or 'the human body'), 4 hours of planning, 6 hours of networking, and unstructured time for socializing.	Experimental Design (Pre-Post Data, no control; Instruments: (1) researcher-designed instrument to measure perceptions and practices of STEM teaching, (2) modified version of Teachers' Pedagogical Discontentment Scale (STPDS), (3) modified version of Inquiry Science Implementation Scale (ISIS), and (4) modified version of the Science Teaching Efficacy Belief Instrument (STEBI).	In-Service Teachers (N=230)	No model stated - STEM was discussed in general terms e.g., value to learners, necessity for modern society.	Statistically significant improvements regarding participants' Comfort Teaching STEM, Comfort with Inquiry Implementation and Efficacy for Teaching STEM were noted. There was also a statistically significant difference in participants feelings of Pedagogical Discontentment relating to STEM teaching whereby these feelings decreased after engagement with the i-STEM summer programme. Correlational studies were also conducted to further demonstrate the positive impact of the PD programme e.g. when levels of efficacy increased, so too did participants' levels of inquiry implementation ($r=.5$) and comfort with teaching STEM ($r=.4$).	(i) Replicability of the PD programme would be difficult (funding, residential etc.), (ii) No real discussion on what is meant by integration	Journal Article (Peer Reviewed)
Nadelson (2014) United States	The authors worked with a number of teachers across six elementary schools over a three-year period to support their understanding and integration of engineering concepts into their day-to-day classroom practice. At the end of this initiative, the authors sought feedback from school leaders to determine what impact their professional development courses had on the culture of the school and the nature of interactions between teachers. The also asked for guidance on the future STEM related professional development.	Qualitative (Interviews)	School Leaders (N=6)	No particular discussions of integration were included beyond its proclaimed value to learners.	Reports from principals/school leaders were largely positive. The leaders noted that students (and parents) appeared to be more engaged in classes where teachers had completed the professional STEM courses provided. The principals/school leaders also reported that their teachers had significantly benefited from the programme and listed the following changes in teacher behaviour that they believe emerged as a result of the professional development provided: improved communication skills, increased collaboration, regular use of inquiry based learning techniques, increased camaraderie, increased collaboration, increased cross-curricular activities and more. School leaders acknowledge as well that there had been a culture shift over the past three years thanks to the initiative with teachers being more open to new ideas and collaboration.	(i) Social desirability (e.g. researchers and principals had developed a working relationship over the past 3 years of the project), (ii) Principal reports may not align with teachers'/students' experiences (inferential distance), (iii) no student outcome data gathered to support comments	Conference Proceedings/ Papers





<p>Nesmith (2017) United States</p>	<p>University teacher educators analysed the manner in which pre-service teachers integrated literacy with their teaching of science.</p>	<p>Qualitative - no specific design is cited (reflections on children's literature; class discussions - recordings; surveys; interviews)</p>	<p>Pre-service elementary teachers (N=64)</p>	<p>The broad literature on science-literacy integration conceptually frames this study.</p>	<p>PSTs who chose not to integrate literacy into their science instruction cited several reasons: (i) perceived that this form of teaching was not valuable, (ii) insufficient time to actually teaching literacy within content-focused lessons, (iii) lack of familiarity/confidence with disciplinary literacy strategies, (iv) 'general indifference' towards literacy strategies. A limited repertoire of literacy strategies were employed; they commonly included introductory activities like KWL charts rather than more higher-order disciplinary approaches.</p>	<p>(i) Very constrained sample (one university course), (ii) observations of practice not formally included, (iii) professors were evaluating their own students</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Nollmeyer () United States</p>	<p>This study examines how five teachers conceptualise and practice integration in the United States. The authors propose a model of integration that captures multiple dimensions of integration (subject areas in integration (number); frequency of integration; delivery of integration; depth of integration) based on the literature and empirical data.</p>	<p>Case study (interviews, observations)</p>	<p>Elementary teachers (N=5)</p>	<p>A thorough review of the literature on integration underpins this study. While a wide variety of integrative models are reviewed, the matrix of integration used to analyse the case was heavily influenced by the work of Huntley (1998).</p>	<p>Individual cases are reported before the presentation of a cross-case analysis based on four common themes: (i) An organising description: All participants viewed integration as the combination of subjects, though each framed it slightly differently; they conceptualised integration as "both a planned and natural process", involving both organic connections and planned subject connections; (ii) Grounded in content: Content-oriented subjects like social studies and science often formed the foundation for integrated units, (iii) Range of options: Teachers recognised that there are multiple ways to integrate, with varying levels of integration, (iv) Perfect world versus reality: Teachers indicated that their 'level' of integration in practice may be lower than they would like.</p> <p>Three contrasting themes are also reported: (i) Philosophical foundations: These varied, with one teacher emphasising the teaching of whole over parts, another emphasising that it must be viewed on a long term (rather than lesson-by-lesson) basis and another emphasising the centrality of team collaboration (amongst teachers) for integration, (ii) Planning structure: Some teachers emphasised themes that</p>	<p>(i) Small sample size, (ii) lack of reference to child outcomes and child perspectives</p>	<p>Journal Article (Peer Reviewed)</p>

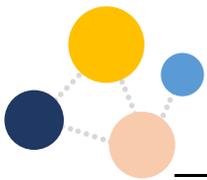




spanned disciplines while other teachers emphasised subjects as the starting point; the level of formal planning versus organic development also varied, (iii) Depth of integration: The 'amount' of integration varied.

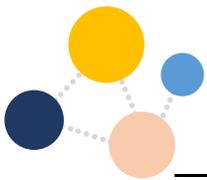
A model of integration mapped across four variables is offered: subject areas in integration (number); frequency of integration; delivery of integration; depth of integration. The claim that integrative practice does not fit easily into a 2-dimensional continuum.

Nugent (2018) United States	This study examined the interdisciplinary instructional strategies adopted by 8 teachers in one case study school. Findings are based primarily on interviews with the teachers and observations undertaken in their classrooms.	Case study (semi-structured interviews, observations, record analysis)	Case Study School (n=1); teachers (N=8)	This study consistently refers to 'interdisciplinary instruction', which is defined as "thematic teaching, or instruction that connects each subject taught through a common concept" (p.8)(citing Resor & Gandy, 2014).	<p>Findings are arranged under three themes:</p> <p>(i) How elementary educators deliver interdisciplinary instruction: participants used a variety of strategies to embed reading in content lessons (e.g. read alouds); students' prior knowledge was identified as an important starting point; other strategies included: explaining lesson objectives, modelling activities, providing optional activities; participants indicated that literacy and maths were the most commonly integrated (with science/social studies); a majority of teachers thought student academic performance benefitted from interdisciplinary instruction; technology was also regularly integrated, alongside relevant reading materials and tactile materials;</p> <p>(ii) How elementary educators consistently use interdisciplinary instruction: various tools were considered helpful for interdisciplinary instruction (e.g. big books to integrate science; 'digital images' to integrate the arts); teachers had positive views of interdisciplinary instruction</p>	(i) Small sample size, (ii) reliance on teacher self-report, (iii) there are issues with the conceptualisation of integration in places	Doctoral Thesis
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<p>Ødegaard (2014) Norway</p>	<p>This study examined how teachers integrated reading, writing, and oral language with practical activities in inquiry-focused science lessons. Video recordings of teaching reveal how these literacy activities were distributed across the different phases of the inquiry lessons.</p>	<p>Observational study (video recordings of lessons)</p>	<p>Teachers (N=6) and their primary-aged students.</p>	<p>The study is framed by the broader literature on synergies between science and literacy: "Inquiry and literacy have a twofold role of providing structures that support science content learning as well as being important areas of content knowledge of the science curriculum" (p.2998). Students participated in lessons that integrated a range of literacy modalities (oral, reading, writing) with inquiry-based science lessons.</p>	<p>(i) Multiple learning modalities were adopted in integrating science with literacy, with primary attention/time being given to oral activity (talk it), (ii) more time was afforded to the beginning phases of inquiry than in the consolidating phases, (iii) the amount of time spent on each phase of inquiry varied from that recommended in teacher guides, (iv) the modalities were used differently in different phases of inquiry, with oral discussion being most common in the discussion/communication phases, (v) key concepts received the most attention in the preparation/discussion phase. The findings contradict the idea that literacy activities received excessive attention when integrated with science (contradicting Howes et al, 2009).</p>	<p>(i) Small scale study, (ii) high level of support provided to teachers, (iii) no outcome data for students collected</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Ollila (2016) United States</p>	<p>This case study analyses how a selection of elementary teachers integrate their social studies instruction with English Language Arts. They report based on their regular practice and perceptions relating to integration; this is not an intervention study.</p>	<p>Case study (interviews, focus groups)</p>	<p>Grade 3-5 elementary social studies teachers (N=14) from one school/school district</p>	<p>Integrated curriculum is defined as "the process of combining or considering content areas by connecting related concepts to facilitate better understanding and performance of students" (p.12), citing VanTassel-Baska and Wood (2010).</p>	<p>(i) Teachers identified both positive and negative effects of integrating social studies into the ELA curriculum; positive effects included increasing instructional time (supporting deeper understanding), enabling a broader coverage of material in both subjects, supporting student enthusiasm/engagement, supporting engagement with non-fiction texts; negative effects included challenges relating to planning, a lack of resources for this integration, (ii) Regarding the impact of this integration on the teaching of civic competence, teachers also identified positive effects (application to real-life situations; developing active members of the community and society) and negative effects (development of negative views on government/politics), (iii) Teachers identified what they considered the best ways of integrating social studies into ELA: classroom projects (incorporating reading/writing activities; incorporating group projects and presentations) and brainstorming with others on how best to integrate</p>	<p>(i) Reliance on teacher report, (ii) no outcome measures, (iii) potential bias due to relationship with researcher</p>	<p>Doctoral Thesis</p>





**O'Neal (2017)
United States**

This study used the 2011 Trends in International Math and Science Study (TIMSS) data to examine inter-subject correlations (biology, maths, science) on student achievement for 4th and 8th grade learners. The study aimed to investigate if TIMSS data could be utilised to establish guidelines on STEM integration so as to assist practitioners and direct the course of future research.

Secondary Analysis of International Large-Scale Data (TIMSS [Trends in International Math and Science Study] 2011)

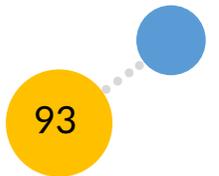
Educational Systems (4th Grade) (n=58); Educational Systems (8th Grade) (n=50)

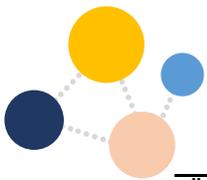
Two key definitions related to curricular integration are provided in this thesis. The first refers to subject integration which the author (based on Van Loo, 2011) defines as ' the application and integration of knowledge from multiple subject areas within the educational arena' (p. 16). The second definition relates to STEM education which is considered 'an interdisciplinary educational approach within science, technology, engineering, and mathematics disciplines' (P. 16; adapted from Davis, 2015).

Student achievement in life science/biology was correlated with achievement in mathematics and other sciences across three analytical areas: mathematics and science student performance, achievement in cognitive domains, and achievement in content domains. The importance of linking student learning experiences between and within STEM domains to support high performance on TIMSS assessments was indicated by correlations of moderate strength ($57 < r < 85$) between life science/biology and mathematics content domains, as well as by stronger correlations ($73 < r < 97$) between life science/biology and other science domains. According to the author, results demonstrated the foundational nature of STEM knowledge at the fourth grade level, and established the importance of strong interconnections among life science/biology, mathematics, and other science. The results from this investigation promote a holistic design of school learning opportunities to improve student achievement in life science/biology and other science, technology, engineering, and mathematics (STEM) subjects at the elementary and middle school levels.

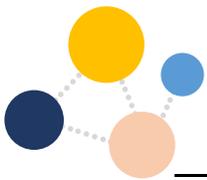
(i) comparisons occurred at the education system level, (ii) Not all STEM subjects were considered in the analysis, (iii) cross country comparisons are inherently problematic due to differences in national curricula (or indeed their absence), (iv) standard measurement issues when working with International Large Scale Assessments

Doctoral Thesis

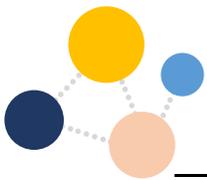




Öztürk Yılmaztekin (2017) Turkey	<p>This study examines the science/art integration practices of five early childhood teachers working in one setting. It provides a description of how both disciplines were integrated, drawing on case study approaches.</p>	<p>Case study (interviews; observations of practice; document analysis)</p>	<p>Early childhood teachers working in the same setting or school (N=5)</p>	<p>The broad literature on integration is invoked, including Beane (1997), Fogarty (1991) and Drake (1993).</p>	<p>Findings are reported under 5 themes: (i) science activities: teachers used a variety of materials to teach science, (ii) importance of science: teachers agreed that science was important and could be developed through interaction with the environment, observation, and investigations, (iii) science teaching methods: a variety of methods were adopted including projects, drama, experiments, (iv) integrated activities/curriculum: teachers viewed integration positively and as something that supported student progress, (v) science and visual art integration: teachers combined science and art, e.g. through drawing, use of junk art. The authors conclude that the project/multidisciplinary approach outlined by Drake (1998) may best capture the work ongoing in the school.</p>	<p>(i) Qualitative analysis led to the identification of quite superficial themes, (ii) very small and bounded sample, (iii) conceptions of art may be superficial (equated with drawing)</p>	<p>Journal Article (Peer Reviewed)</p>
Öztürk Yılmaztekin (2016) Turkey	<p>This study examines the perceptions of pre-service early childhood teachers' (n=20) views of curriculum integration. Data is drawn from reflective papers and interviews.</p>	<p>Interviews and reflective papers (no overall design mentioned)</p>	<p>Pre-service early childhood teachers (N=20); (n=10 participated in interviews, n=20 participated in reflective exercise)</p>	<p>The introduction to the study reviews a number of integration models including Fogarty, Drake and Jacobs, but does not endorse any given one.</p>	<p>(i) Participants' definitions of integration tended to emphasise the idea of 'combining something in order to foster meaningful learning' (p.38); despite having learned about models of integration in their programme, few explicitly mentioned or remembered them; participants emphasised the benefits for concept/skill development in a meaningful manner, (ii) participants addressed both positive (e.g. creative thinking; enjoyment; engagement; meaningfulness) and negative aspects (e.g. ability to plan; potential for confusion; time taken to plan/prepare) of curriculum integration ; most had not seen integrated teaching on their placement, (iii) Participants felt that the flexibility in the national curriculum enabled curriculum integration</p>	<p>(i) Very small sample, (ii) relationship between researcher and the participants could be given greater focus in the write-up, (iii) pre-service educators' views may not reflect those of practicing educators, (iv) reliance on self-report</p>	<p>Journal Article (Peer Reviewed)</p>

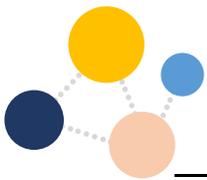


<p>Panagopulos (2015) United States</p>	<p>Two distinct studies were involved in this dissertation. Study 1 examined the impact of arts-integrated instruction on the reading scores of students qualifying for the free and reduced meal benefit (FARMS) at five different schools compared to similar peers in schools that do not use arts-integrated instruction. Three years of standardised test data contributed to this study. Study 2 examined the arts-integration practices of teachers using classroom observations and semi structured interviews.</p>	<p>Study 1: Quasi-experimental Research (Test score data [Maryland School Assessment of Reading]; Group 1 (AI schools): n=344, Group 2(Non-AI schools): n=383), Study 2: Qualitative Research (Observations, Interviews)</p>	<p>Study 1: N=727 Grade 3 learners; Study 2: N=20 (Interviews; 15 teachers and 5 principals), n=11 (classroom observations)</p>	<p>The author offers this definition of Arts-Integration: an approach to teaching in which students construct and demonstrate their understanding through an art form. Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both (p. 13). The author further states that high quality learning outcomes can only be achieved when a co-equal cognitive integration style of AI is implemented.</p>	<p>Study 1: Within all five AI schools, the mean change for FARMS students exceeded mean change for non-FARMS students, while this was the case for three out of five non-AI schools. There were no statistically significant differences in MSA reading change scores between non-FARMS and FARMS students. Mean reading change scores for the grade 3 cohort of students showed that students in AI schools outperformed students in non-AI schools during the year that they were in grade 3 (2011). This trend did not continue through grades four and five (small effect sizes calculated). Study 2: Key themes that emerged from the observation of AI classrooms included: shared vision, culture, rigor, engagement, achievement, teacher capacity. The interviews with principals and teachers noted that AI supported the development of a shared school visions, and increased student achievement (particularly for underperforming students) due to the increased level of cognitive rigor and engagement.</p>	<p>(i) Generalisability difficulties (different forms of art integration may be used in different schools due to inconsistencies in definitions), (ii) suitability of outcome measures and Maryland formula to calculate growth, (iii) non-integrated AI classrooms were not observed (making some statements difficult to have complete confidence in), (iv) contextual factors may have influenced teacher responses/practices (curricular reform in Maryland), (v) sample sizes were inconsistent (see p. 60)</p>	<p>Doctoral Thesis</p>
<p>Parker (2012) Great Britain</p>	<p>Pre-service teachers participated in a three-hour art/science cross-curricular session jointly planned between three PGCE tutors (including one from each of art and science). Participants contributed perceptions beforehand via a questionnaire and afterwards via a small group discussion.</p>	<p>No overall design stated (questionnaire, small group discussion)</p>	<p>Pre-service teachers (N=10) on a PGCE programme</p>	<p>The authors point out that a variety of terms are in use, but adopt 'cross-curricular learning', citing Barnes (2007) to define as "the application of skills, knowledge and attitudes of different disciplines to a single experience, theme or idea ... it also incorporates the interdisciplinary dimension of linking subjects to develop conceptual insight into particular phenomena." (p. 694)</p>	<p>(i) Before participation in the cross-curricular session, PSTs expressed positive views of cross-curricular approaches (e.g. motivating, more creative, more interactive, saves time) but also identified challenges (e.g. covering subject matter/objectives, planning), (ii) after the cross-curricular session: students could identify aspects of both science/art that were taught; benefits were identified (e.g. avoiding compartmentalisation; 'meaningful learning'; increasing motivation); challenges were identified (e.g. balancing subjects; sequencing of lessons; planning; assessment)</p>	<p>(i) Very small sample size, (ii) potential for researcher effects/power issues - researchers investigating their own students, (iii) very short 'intervention' (one three-hour session)</p>	<p>Journal Article (Peer Reviewed)</p>



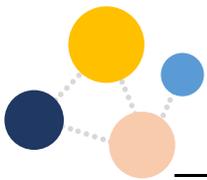
Penchalk (2015) United States	<p>This case study examines how middle school teachers integrated at an incidental level. Qualitative data are used to report on teacher perceptions of this form of integration. Myers-Briggs Type Indicator (MBTI) profiles are generated for each participant, though their import is not conceptually clear.</p>	<p>Case Study (observation; documentary analysis of lesson materials; interviews; focus groups; teacher reflective journals; Myers-Briggs Type Indicator)</p>	<p>Teachers (N=9) from three middle schools provided all necessary data/consent</p>	<p>The term 'interdisciplinary' is used throughout this research project to describe integration. The conceptual work of Maute (1992) on 'cross-curricular connections' is important in framing the study; this framework envisages a hierarchy as follows: "At the base of the pyramid is the cross-curricular incident and proceeding gradually up the structure find activity, then assignment, followed by unit, and finally at the apex is the event (Maute, 1992, pp. 74-75)". Cross-curricular integration at the incident level refers to the bottom rung of the hierarchy and relies on an awareness of the connections between disciplines. The work of Hayes-Jacobs (1989) in defining interdisciplinary curriculum is also cited.</p>	<p>Key themes from interviews and observations included: (i) Comfort with cross-curricular connections: teachers were generally comfortable with making incident-level connections within their teaching, (ii) Application of cross-curricular connections: teachers noted that spontaneous connections were more interesting to students, (iii) Cross-curricular connections in lessons: co-operation between teachers supported these connections across the middle school, (iv) Discussion of time constraints in planning/preparation/implementation. Key themes from focus groups included: the importance of bringing everyday events/current affairs into teaching of subject areas; the challenges of collaborating with other teachers to achieve integration (including time constraints) Key themes from the follow-up interviews included: continued focus on interdisciplinary connections; examples of integration across subjects (history/ELA) MBTI results are also reported, though their implications are not clear.</p>	<p>(i) Conceptual gaps in how MBTI results are linked with the broader data set (and the rationale for including these results), (ii) large time lags between time 1 and time 2 interviews with accompany attrition between time points, (iii) lack of clarity in how observational data was reported, (iv) large reliance on teacher self-report</p>	<p>Doctoral Thesis</p>
Pendergast (2012) Australia	<p>This study is part of a broader project (Mills et al., 2008) that focused on practice in middle years classrooms (Y4-9) in Mathematics, English, Science and Studies of Society and the Environment. Observation data on the quality of pedagogy was compared across discrete learning subjects (e.g. English on its own) and integrated learning lessons. Analysis of this quantitative data revealed higher quality pedagogy scores for those lessons that were integrated (p<0.0001). Survey data - though drawing on a smaller sample - indicate that teachers do not integrate in reality as much as they would like to.</p>	<p>Case Study (Observation Tool - Productive Pedagogies Observation Framework, Teacher Survey)</p>	<p>18 Case Study Schools (386 lesson observations); survey responses (n=74) from teachers including primary/post-primary settings</p>	<p>The study foregrounds the conceptualisation of integration offered by Beane (1996), characterised by four main characteristics: i) organisation around important problems; ii) a focus on relevant knowledge rather than relevant subjects; iii) a focus on the problem rather than tests/grades; iv) a focus on real world applications (e.g. projects). The authors highlight the importance of working across disciplines in the middle years.</p>	<p>Higher quality pedagogy was observed in integrated as opposed to subject-specific lessons, as measured by the Productive Pedagogies Observation Framework, (p<.001).</p>	<p>(i)There is little information about other potential confounding factors (e.g. were better teachers more likely to integrate, thus causing higher quality scores?)</p>	<p>Journal Article (Peer Reviewed)</p>



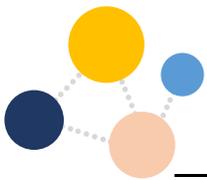


<p>Penna-Baskinger (2018) United States</p>	<p>This study examines teachers' perceptions on 'theme-based' teaching in a school district that does not formally adopt integrated teaching. Data are drawn from twelve interviews with teachers, who speak about their regular practice and their thoughts on integration.</p>	<p>No overall design cited - qualitative (structured interviews; questionnaires; field notes)</p>	<p>Teachers in grade 3-8 (N=12)</p>	<p>The conceptual framework for the study refers to theme-based learning, citing Lam et al (2012); however, Lam et al (2012) refers more broadly to different models of integration (e.g., multi/inter/trans). The author goes on to define 'theme-based' as involving "the curricular integration of common themes and disciplines that can enable students to see relationships between subjects and content relevance" (p.12). The term 'cross-curricular' is also defined as being interchangeable with terms like "integrated, interdisciplinary, multidisciplinary, transdisciplinary, blended, crossdisciplinary, thematic, or topic-based approaches" (p.13). Integrated curriculum is defined as "curricular programs that are aimed toward making subject matter more relevant and meaningful to students by delineating disciplinary—or domain specific—boundaries around various types of learning (Lam et al., 2012)" (p.14)</p>	<p>Some key findings include (i) There was variation in the terms used by teachers (theme-based; integrated; cross-curricular), (ii) Teachers viewed theme-based lessons as having a positive impact on student engagement and outcomes; teachers provided multiple examples of different times they used theme-based teaching, (iii) There were varying views on whether integrated teaching led to changes in teaching approach; half of the participants felt that theme-based lessons did not necessitate special planning time/considerations; challenges identified included lack of time and assessment-driven; teachers indicated that PD to support theme-based teaching would be welcome;</p>	<p>(i) Small sample size, (ii) depth of analytic approaches used</p>	<p>Doctoral Thesis</p>
<p>Pepler (2014) United States</p>	<p>This paper examines the impact of a school arts program (Learning and Achieving Through the Arts - LATA) involving a community arts organisation and a school district (in LA). Control schools taught the arts as part of their curriculum but did not engage in arts integration using the LATA model. Standardised ELA test scores from state assessments are compared across treatment and control schools.</p>	<p>Quasi-experiment - schools matched based on several indicators (California State Test of English Language Arts - CST-ELA)</p>	<p>Schools (N=6); control (n=3), treatment (n=3)</p>	<p>This study focuses on arts integration; broader models of curriculum integration are not invoked. The LATA model involves high quality, standards based, sequential teaching in the arts with a focus on both arts knowledge/skills and language development. Both visual and performing arts are addressed.</p>	<p>Chi-square analysis of the proportions of students achieving or surpassing a 'proficient' score across treatment/control schools indicated that: baseline scores were higher in the control schools [chi-squared (1, N = 3077) > 0.000001; p < .001] but from year 1 of implementation they were consistently higher in the treatment schools (Year 1: chi-squared (1, 2960) > 0.00098; p < .01; Year 2: chi-squared (1, 2868) > 0.00006; Year 3: chi-squared (1, 2762) > 0.00004; p < .01). Analysis of ELLs' scores showed even more substantial differences between conditions.</p>	<p>(i) More sophisticated statistical analysis needed to fully account/control for differences between schools (chi-square analysis is somewhat limited), (ii) analysis based on school-level data rather than data for individual students, (iii) other confounding variables (relating to inter-school differences) not</p>	<p>Journal Article (Peer Reviewed)</p>



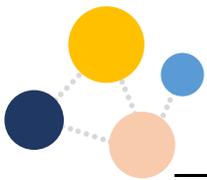


						accounted for, (iv) ELA scores may not be the best measure (how is learning in the arts captured?)	
Potocnik (2021) Slovenia	This study analysed how primary teachers in Slovenia integrated science with fine art, drawing on an 'interdisciplinary approach'. Their usual practice was investigated using questionnaires, interviews and analysis of a sub-sample (n=30) of lesson plans that integrate both subjects.	Mixed methods (interviews; questionnaire; documentary analysis of lesson plans)	Primary teachers (N=138)	The term 'interdisciplinary' is used to refer to integration in this paper. It is characterised as follows: "An interdisciplinary approach itself fuses the methods and characteristics of multiple fields (Jones, 2009). With an interdisciplinary approach, pupils develop lasting knowledge (Lupo et al., 2019)." (p.435)	(i) Teachers overwhelmingly saw interdisciplinary integration of science/fine art as a meaningful and useful endeavour; in their view, this is something that supports student learning, (ii) Benefits identified included: better memorisation/learning of concepts; greater student interest; clearer presentation of materials/problems; Limitations included: the view that science can be more easily integrated with other subjects; potential to neglect art in this form of integration, (iii) 52% of teachers integrated these subjects occasionally (about once a month), with the rest using it less regularly, (iv) examples of integration deemed meaningful included linking forces and motion in science with line in art, (v) analysis of 30 lesson plans indicated shortcomings, e.g. no lesson plan clearly included objectives from both disciplines; the researchers' analysis indicated that only 13 (43%) had clear content from both disciplines (Despite being flagged by participants as being interdisciplinary)	(i) Potential gap between lesson plan documentation and actual practice	Journal Article (Peer Reviewed)

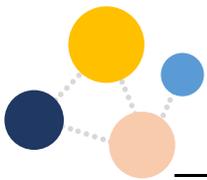


<p>Powell (2018) United States</p>	<p>This study examines how three elementary teachers integrate social studies with literacy instruction.</p>	<p>Multi-case study (semi-structured interviews; observations; lesson plans, photographs, researcher journal)</p>	<p>Elementary teachers (K, 3rd, 5th grade - one school) (N=3)</p>	<p>The author states that integrated curriculum "focuses on the learner as a whole and recognizes that learning is complex and interactive, not linear" (p.31); Jacobs (1989) and Fogarty's (2009) models of integration are explored in the literature review. Disciplinary literacy is given attention in the literature review.</p>	<p>The cross-case analysis identifies the following themes: (i) conflicts between beliefs and practices: e.g. teachers indicated that they felt curriculum integration (literacy/social studies) was beneficial, but this focussed mainly on memorisation in two of the classrooms, (ii) Use of school-district curriculum maps varied from teacher to teacher, with one teacher implementing it rigidly, (iii) Lack of social studies materials, (iv) Need for PD expressed by each teacher, (v) Lack of opportunities for extended writing, (vi) Censorship: teachers avoided sensitive topics, (v) the researcher reports a variety of 'missed opportunities' from her observations, including a lack of connection to current events.</p>	<p>(i) Small sample size, (ii) likely not generalisable</p>	<p>Doctoral Thesis</p>
<p>Quigley (2019) United States</p>	<p>This 3-year longitudinal study examined how STEAM teaching practices are enacted in different educational settings. The study pays particular attention to the curriculum implementation strategies deployed by teachers. All teachers underwent (at a minimum) a 40 hour professional learning course. The teachers experienced a STEM unit as students and then designed a STEAM unit for their classroom, which they received feedback on. During the implementation of these units, the teachers were observed on two occasions. Teachers also completed a weekly reflective journal throughout the 12-16 week implementation of the unit. The current study offered a qualitative analysis of the data gathered.</p>	<p>Longitudinal Study involving qualitative data (Observation Tool, Weekly Reflective Journal)</p>	<p>In-Service Middle School Teachers (n=14 schools), In-Service Elementary School Teachers (n=2 schools); n=72 teachers</p>	<p>The authors credit Yackman's (2007) framework for STEAM learning as a major influence on their work. The framework involves integrating all disciplines but in a way that elevates 'science and technology over engineering and art... but connects them through mathematics' (Quigley et al., 2019, p. 144). However, the authors query the role of arts in STEAM to inform other disciplines instead of being an integral component in their own right. To address this shortcoming, the authors incorporated 'Social Practice Theory' into their conceptualisation of STEAM which advocates 'collaboration outside of school setting, discipline integration, and relevance across fields' (p. 145), thus justifying their use of socially situated, authentic, problem-solving tasks for learners.</p>	<p>Three components contributed to the overall success of a STEAM unit: teacher conceptualisations of STEAM, relevant problem-based curricula design, and flexibility in enactment.</p>	<p>(i) Not linked to other data gathered in the longitudinal study, (ii) researcher-designed observation tool, (iii) unclear data analysis methods</p>	<p>Book Chapter (Edited Book)</p>





<p>Revelle (2019) United States</p>	<p>This study examines the perceptions and experiences of teachers who have enacted project-based units integrating social studies and literacy. Interviews were carried out with teachers at the end of the school year. The findings are part of a broader study on project-based learning.</p>	<p>Interviews [part of a larger cluster randomised trial on project-based learning; this study examines teacher perceptions]</p>	<p>Second grade teachers (N=24)</p>	<p>This study focuses on integrating literacy with social studies in the context of project-based learning. Project-based learning serves as the overall conceptual framework, rather than models of curriculum integration.</p>	<p>Findings are reported under a number of themes/headings: (i) Teachers' perceived successes and challenges: (i) teachers felt empowered by the instructional materials/curriculum and its new approaches, (ii) teachers reported that students were very engaged in the curriculum, (iii) teachers reported gains in students learning in a number of areas, such as social studies and their ability to use evidence in their writing, (iv) over half of teachers felt that the project-based approach was attainable and practical, (ii) Contributing factors perceived by teachers: (i) the instructional materials provided to teachers were welcomed and included step by step guides; the integration of literacy and social studies saved time; some teachers felt that the curriculum was too 'rigorous' while others felt that it was appropriately challenging; its experiential nature and focus on authentic purposes were successful, (ii) time was a large challenge, (iii) children's lack of prior knowledge (e.g. literacy; knowledge of the local community) was also a challenge. The author also reports that there were stark differences from teacher to teacher when a cross-case analysis was conducted.</p>	<p>(i) Reports qualitative data only (though broader findings are highlighted elsewhere), (ii) lack of outcome data; reliance on teacher self-report</p>	<p>Journal Article (Peer Reviewed)</p>
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**Revelle (2020)
United States**

Study 1 involved a case study of one third grade teacher's enactment of a civic education unit drawing on project-based approaches. Study 2 involved a collective case study of two teachers' approaches to enacting writing instruction within the same civics unit.

Study 1: Case study (observations, video recordings, interviews, analysis of artifacts/student work)
Study 2: Collective case study (observations, video recordings, field notes, interviews, classroom artifacts)

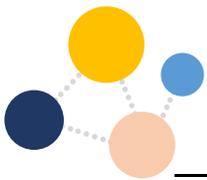
Study 1: third grade teacher (n=1) who had previously collaborated on the design of a third grade civics project unit; n=4 focal students from her class
Study 2: third grade teachers (n=2) from two different schools

This study is framed around project-based approaches to integrating civic education (social studies) and literacy. Models of integration are not cited.

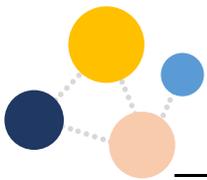
Study 1: Findings from study 1 report on notable aspects of the teacher's approach to enacting the unit. The researcher draws attention to: how the teacher modelled care and responsiveness in interactions with students; strategies used to support discussion and collaboration (e.g. turn and talks); strategies used to elicit and support students' participation (e.g. 'warm calling', when a student is given notice that their opinion/thoughts will be sought); the manner in which the teacher encouraged the exploration of multiple, sometimes competing, perspectives within the classroom.
Study 2: Findings are reported in line with the key recommendations for writing instruction from the What Works Clearinghouse (Graham et al., 2012). The researcher found that there was ample scope to embed high quality writing instruction within units, drawing on the following tenets: daily time to write, teaching about and through the writing process, promoting a sense of audience, using mentor texts, supporting the production of writing in various forms (e.g. typing), supporting the creation of a community of writers.

Study 1: (i) small sample size, (ii) knowledgeability of teacher may be unique (other teachers enacted the unit may not have designed it), (iii) potential researcher effects, (iv) outcome data not reported
Study 2: (i) small sample size, potential researcher effects, (ii) outcome data not reported

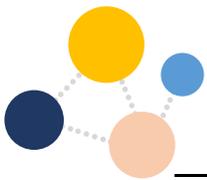
Doctoral Thesis



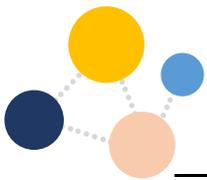
<p>Rico (2020) Spain</p>	<p>This study examined the impact of an interdisciplinary teaching-learning sequence (TLS) about air quality on pre-service primary teachers' attitudes, self-efficacy and perceived relevance of Education for Sustainable Development (ESD). The design involved a curricular integration of concepts and competences about sustainability, mathematics, and science disciplines following constructivist and active learning strategies, such as problem-based learning and place-based education.</p>	<p>Mixed Methods (Pre-Post intervention data gathered using researcher-designed questionnaires regarding [1] understanding of STEM-related content, [2] satisfaction about the STEM-ESD intervention, [3] self-efficacy and [4] perceived relevance of ESD)</p>	<p>Pre-Service Teachers (N=24)</p>	<p>The authors note that STEM is a 'meta-discipline' that addressed content in an integrated way. However, they argue that the interdisciplinary approach at the heart of STEM and the the different STEM practices associated with it (ways of doing, thinking, and talking in science, mathematics, or engineering) can align well with ESD given their common use of authentic contexts and problems, teamwork, and issues involving overlapping scientific and technical areas. The authors cite Sterling (2014) and Lozano (2020) to justify the following approach regarding the curricular integration of sustainability: 1. Understanding the principles of sustainable learning, 2. Identifying key issues in sustainability in each discipline or area of knowledge, 3. Creating opportunities for students to develop skills for sustainability, 4. The use of key pedagogical approaches for sustainable development, such as PBL and place based education, 5. Experimenting with interdisciplinarity and, 6. Being a part of the university or school community.</p>	<p>Pre-Service teachers' specific knowledge about air quality and meteorology improved after the implementation. The authors noted that the pre-service teachers' had a number of worrying misconceptions about climate change that aligned with the view of primary school aged children. Students were very satisfied with the intervention. 93% of students stated that they saw themselves capable of describing "how human activities can impact the environment" easily or with little effort. In the post-test, 60% of students saw themselves as able to "educate others about sustainability issues" with little effort (79%) or no effort (14%), while only 7% felt it would be a difficult task</p>	<p>(i) sample size, (ii) short intervention time, (iii) self-report measures</p>	<p>Journal Article (Peer Reviewed)</p>
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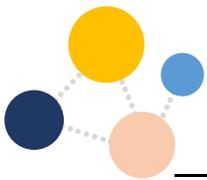
Rismiati (2012) Indonesia	This study examined primary teachers' 'stages of concern' and their implementation of 'Integrated Thematic Instruction' in Indonesia using survey data (n=150).	Cross-Sectional Quantitative Survey (Survey using items from 'Stages of Concern Questionnaire' [Hall & Hord, 2001], Integrated Curriculum Implementation Scale [researcher-designed])	In-Service Teachers (N=150)	The author's definition of CI aligns with how the Indonesian Ministry of Education defines 'Integrated Thematic Instruction' (ITI) which states that instruction to learners should use 'themes to connect multiple subject matters in order to provide students with meaningful experiences'. ITI, therefore, organises integration around 'macro-themes' that integrate basic disciplines like reading, math and science with the exploration of a broad subjects such as communities, rain forest etc.	The study found that teachers' degree of 'ITI' (Integrated Thematic Instruction) implementation was quite high five years after the introduction of this initiative. Administrative support was the most important predictor of ITI implementation (Beta Value: .364, followed by number of students taught (.245) and educational degree(.234)).	(i) convenience sampling techniques used, (ii) limited range of data gathered, (iii) use of some researcher-designed instruments, (iv) self-report measures used/limited range of data gathered to support conclusions	Doctoral Thesis
Robinson (2021) United States	This study examined how an integrated STEM teaching model influenced 5th grade students' perceptions of their mathematics and engineering abilities. The teaching model used a 'real life' issue (access to clean water) as a learning context.	Sequential mixed-methods research design (Post-Intervention interviews; Pre-, mid- and post-intervention surveys that used items from the following instruments: (1) The Patterns of Adaptive Learning Survey, (2) Mathematical Attitude Assessment, (3) Engineering Skills Self-Efficacy Scale, and (4) Intersectionality of Non-normative Identities in the Cultures of Engineering Survey	5th Grade students (N=17)	No in-depth discussion or conceptualisation of curricular integration was provided. However, the supplementary materials demonstrated how key elements of each discipline were addressed in an integrated manner for each lesson e.g., Week 4: Engineering (providing labels and measurements for filtration devices), Science (determining the saturation of a solution), Maths (writing a numerical expression for saturation)	Quantitative data indicated a decrease in mathematics self-efficacy but an improvement in perceived mathematics usefulness from mid-unit to post-unit. There was no statistically significant change in students' Engineering Self Efficacy scores throughout the intervention. Interestingly, the qualitative data indicated an increase in students' confidence to do difficult math at the end of the unit. However, previous experiences with maths appeared to influence students' overall progress towards higher levels of self-efficacy for mathematics. The authors assert that their results indicated that integrated teaching approaches can foster 'positive shifts' in students' perceived STEM abilities.	(i) No role for technology in the study, (ii) Unequal emphasis on disciplines, (iii) researcher bias may have been present due to their involvement in the unit's delivery, (iv) sample size, (v) no specific achievement data	Conference Proceedings/ Papers



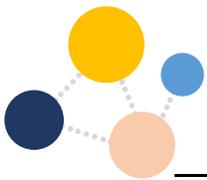
<p>Rosenthal (2020) United States</p>	<p>This case study examines how staff in one K-8 school went about adopting innovative approaches to teaching, with some reference to curriculum integration.</p>	<p>Case study (interviews, observations, field notes, documentary analysis)</p>	<p>School in Massachusetts (n=1); (n=800 students); n=14 educators took part in the case study</p>	<p>Integration is not explicitly outlined, defined or conceptualised in this study.</p>	<p>Findings are reported under four themes: (1) Adult collaboration: Collaboration grew naturally once sparked by a teacher particularly interested in innovative practice; this led to the formation of a STEAM team that occurred during planning/collaboration periods on the timetable; teachers shared advice on STEAM approaches, (2) Curriculum adaptation, delivery and outcomes: Teachers felt that they needed to adapt state/district curriculum demands to suit more innovative practices; new resources were purchased to support STEAM projects (e.g. 3D printer, robots), (3) Administrative and community support: Openness from administration was crucial; attitudes supported experimentation and failure, (4) Professional development: This was supported by visits to other schools that demonstrated exemplary STEAM practices; modelling and sharing experiences with colleagues internally was also important.</p>	<p>(i) Sample size, (ii) lack of learner outcomes, (iii) lack of specificity in reporting on integration</p>	<p>Doctoral Thesis</p>
<p>Rule (2012) United States</p>	<p>This study examined attitudes towards a range of curriculum issues (e.g. use of arts integration, project-based instruction, student-centred learning) before and after participation in an arts-integrated unit on Africa. Pre-service teachers experienced many arts-integrated lessons in the university classroom and created authentic papier-mâché masks of different African cultures before assisting, as part of a practicum experience, first and second graders in similar arts-integrated lessons related to Africa that included making papier-mâché masks.</p>	<p>Quantitative Study (Pre-Post Test Data using researcher designed assessments; no control)</p>	<p>Pre-Service Teachers (N=65)</p>	<p>No particular model or conceptualisation of arts integration was invoked.</p>	<p>Pre-Post data analysis indicated that student attitudes for three particular statements demonstrated movement in the 'positive' direction (value of arts-integrated curriculum, value of student centred approaches, enjoyment of planning for PBL sessions). Student attitudes showed the most movement (with a medium effect size) toward recognizing that an arts-integrated curriculum could actually address standards and teach students social studies content, rather than being a fun "fluff" activity.</p>	<p>(i) generalisability concerns (contextual factors), (ii) power imbalance (researchers were participants' teachers), (iii) suitability of outcome measures (reliability, validity), (iv) suitability of statistical analyses</p>	<p>Journal Article (Peer Reviewed)</p>



Sáez-López (2016) Spain	<p>This study analysed the potential benefits that coding with a visual programming language ('Scratch') may have on the affective and academic functioning of learners when it is integrated with the science- and art-based subjects. The study occurred over a two year period where students participated in 20 one-hour coding sessions that were integrated with science and arts concepts.</p>	<p>Quasi-experimental using a design-based research strategy (Pre-Post data gathered using Visual Blocks Creative Computing Test [VBCCT]; post-intervention data was gathered using researcher-designed questionnaire that addressed topics related to active learning, knowledge of art history concepts, computational concepts, perceived usefulness of course, and enjoyment [validity and reliability checks provided e.g. Cronbach's alpha=7.89]; rubric based on Bloom's taxonomy to assess student projects)</p>	<p>5th/6th Grade Learners (N=107)</p>	<p>Coding/Computational Thinking activities were integrated into science/arts lessons. No particular integrative framework informed the project - it seems that the subjects provided the context for the learners to engage with coding/computational thinking.</p>	<p>Significant improvements in Visual Blocks Creative Computing Test [VBCCT] from pre- to post-intervention; Students achieved an above-average understanding of art and history concepts; High levels of perceived usefulness; Working with visual languages provided fun, motivation, enthusiasm, and commitment from the student.</p>	<p>(i) no randomisation of groups, (ii) inadequate description of intervention - the roles of teachers and learners etc. in this study are very unclear, (iii) Use of VBCCT to infer improvements in computational thinking skill may have been flawed given the absence of a control group</p>	<p>Journal Article (Peer Reviewed)</p>
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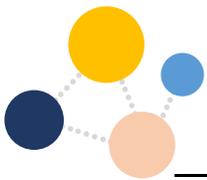


<p>Samuels (2019) United States</p>	<p>This study was spurred by the researcher's observation that some students in their class, including children from a low SES background, were uninterested in social studies and were disengaged/disruptive as a result. The treatment group (taught by the researcher) in this action research undertook a thematic unit on World War One over the course of ten lessons (two weeks); history was integrated with art, math, science, music, ELA and literature/drama.</p>	<p>Action research (survey of student subject preferences; pre/post-test of MCQs on WW1 knowledge drawn from a test bank; Likert questionnaire of attitudes to social studies; observations; semi-structured interviews)</p>	<p>Seventh graders (N=40); control group (n=14), treatment group (n=26); intact classes</p>	<p>Thematic units are defined as "curriculum unit of study that is organized around a general theme and incorporates different subjects across the curriculum into the main theme"(p.21). Integrated teaching (which the author states can be used interchangeably with the term 'interdisciplinary') is explained as: "utilizing different subjects/content areas in teaching a topic or theme to increase student interest and engagement, help students to make connections, save time, address students' multiple intelligences, improve learning outcomes, and aid in long term retention of content"(p.21). Arts integration is also addressed in the literature underpinning the study. However, the examples of integration provided for some subjects (e.g. art) in this study may not be in keeping with the principles/epistemologies of each; surface level integration evident (e.g. colouring in a map).</p>	<p>(i) Analysis (descriptive) of student interest surveys indicated that treatment group students were no more or less likely to signal social studies as a preferred subject after the intervention (only pre- data were collected with the control group); on direct measures of attitudes towards social studies, attitudes declined post-intervention; (ii) Analysis of student scores on the WW1 test indicated that both the treatment and control group made statistically significant gains from pre to post, but that there was no difference between each group at post (note that multiple t-tests were used rather than an ANOVA analysis), (iii) Limited analysis of brief student responses to interviews indicated that they were positive about the unit, but others stated "it was all over the place and very confusing"; there were mixed opinions on student perceptions of thematic. v 'traditional' teaching; some evidence that students who did poorly on the social studies test were more likely to express negative sentiments towards thematic teaching, (iv) observational data indicated that student interest in the unit decreased as time passed;</p>	<p>(i) Short duration of study, (ii) use of intact groups, (iii) potential researcher effects (researcher worked with control group; another teacher with the treatment), (iv) researcher indicates that students were uneasy/ hesitant in responding during interviews, (v) limited statistical analysis (small quant data set) on some data, use of multiple t-tests rather than ANOVA (or another analysis), (vi) confounding variables likely had an impact on the results reported</p>	<p>Doctoral Thesis</p>
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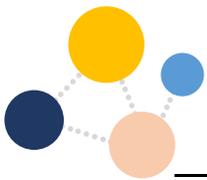
Santaolalla (2020) Spain	<p>This study examines how PSTs' perceptions of interdisciplinary teaching were improved through designing and enacting a unit of work in a local National Archaeological Museum. These units were subsequently enacted with primary school children. Mixed results are reported.</p>	<p>Study 1: Quasi-experiment (pre-post) with non-equivalent control group (non-randomised)(researcher-designed questionnaire pre/post which measured key skills relevant to interdisciplinary teaching; focus group) Study 2: Quasi-experiment (pre-post) with random group assignment (researcher-designed questionnaire pre/post on perceptions of the museum for learning/knowledge of social science/ knowledge of mathematics)</p>	<p>Study 1: pre-service teachers (n=26); Study 2: year 7 students (n=58) randomly assigned by the school to test/control</p>	<p>This study adopts the term 'interdisciplinary learning'.</p>	<p>Study 1: Based on ANOVA analyses of the researcher-constructed scales, PSTs improved on a number of measures captured in the researcher-designed scale (e.g., knowledge integration, interdisciplinary teacher education). Focus group data indicated that participation in the project supported self-efficacy for interdisciplinary teaching and improved perceptions of non-traditional teaching methods. Study 2: Based on ANOVA analyses of the researcher-constructed items, all students (both control and test groups) improved their knowledge; it was not possible to conclude that interdisciplinary learning at the museum explained the difference in learning.</p>	<p>(i) Quantitative analysis completed with very small sample and group sizes that were non-equivalent (Study 1), (ii) researcher-designed instrument; ambiguity in reporting of some results</p>	<p>Journal Article (Peer Reviewed)</p>
Saraniero (2014) United States	<p>This study compared the effects of two contrasting approaches to teacher professional development in arts integration – a summer institute model and a model combining the summer institute with instructional coaching. The study was organised by the DREAM (Developing Reading Education with Arts Methods) initiative (based in the state of California).</p>	<p>Quasi-experimental research (3 groups = Control Group, Institute Only Group, Institute+Coached Group: California Standards Test Language Arts test; Project-Developed surveys that addressed demographic data, teacher knowledge, confidence etc.; Project-Designed rubric to assess lesson plans)</p>	<p>In-Service Teachers (N=116)</p>	<p>No model of integration was invoked but the authors seem to consider that arts integration is a key methodology for improving learning in other subject areas.</p>	<p>Coached teachers reported greater confidence integrating the arts, produced higher-quality work samples, taught more reading concepts with arts integration, implemented more arts standards, and used arts integration more frequently than did the institute-only teachers or the control group teachers. There were significant differences found between groups in the third grade pre-test but no significant difference between groups in third grade post-test. There were significant differences found between the coaching and comparison groups in the fourth grade pre-test and post-test. However, a lack of post-hoc tests on the pre-test data makes it difficult to completely interpret these findings.</p>	<p>(i) significant funding attached to the study (e.g. teachers received stipends to participate in the PD course/study), (ii) Sample size (iii) Post-Hoc tests seemed to indicate that on some measures there were no statistically significant differences between the two treatment groups, even though descriptive statistics showed higher scores for the institute+coached group (e.g. p. 11), (iv) Content of the PD delivered was not clearly explained,</p>	<p>Journal Article (Peer Reviewed)</p>





						(v) Student test-scores were not equivalent in the pre-test stage (making interpretation more complex)	
Savage (2016) Canada	This study examines the experiences and perceptions of teachers who have enacted transdisciplinary approaches to teaching, drawing on the IB model.	Phenomenology (interviews)	IB PYP educators (N=24) (teachers, coordinators, administrators) drawn from each of IB's three geographic regions	This study focuses firmly on the idea of transdisciplinary curriculum, citing a variety of relevant authors (e.g., Drake, 2012; Cantar & Brumar, 2011). The IB curriculum under study is based on a transdisciplinary framework.	Findings are reported under three main themes: (i) "It's a Framework": The framework promoted 'freedom', flexibility and customisation to suit the local school context, which many teachers welcomed; some however noted that the framework is 'vague' and unstandardised; teachers viewed transdisciplinary teaching as an endeavour that transcended or rose above disciplines, drawing on real life situations; teachers noted that the PYP framework was potentially overly complex and consequently confusing - participants had difficulty in clearly articulating their understanding of each part of the framework (central idea, key concepts, related concepts, transdisciplinary skills, IB learner profile); (ii) "Get on Board" - a theme that deals with the components needed for transdisciplinary teaching to work: participants noted the importance of having an appropriate philosophy/attitude (e.g. inquiry-focused) to adopt transdisciplinary teaching; relatedly, the school leadership must be 'on board' with the vision; timetabling is a major consideration - it must be flexible; the use of 'special teachers' may run counter to transdisciplinary teaching, particularly if collaborative planning time with the 'home room' teacher is not available; this collaborative planning is crucial for success but challenging to arrange; planning using backward design and the PYP planner was liked by most participants, but was also deemed time consuming, overly structured, and complex, leading some teachers to use their own versions of planning tools once	(i) Potential sampling bias/self-selection, (ii) reliance on teacher self-report	Journal Article (Peer Reviewed)





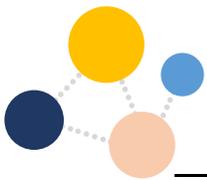
					the unit was planned; it is difficult to induct new teachers into transdisciplinary teaching; effective PD for transdisciplinary teaching is rare and hard to come by; (iii) "Their learning journey" - addresses student learning: in the view of teachers, rich performance assessment tasks (RPATs) contributed greatly to student learning and experience, with many examples offered; transdisciplinary units allowed ample opportunities for students to direct their own learning (examples include genius hour/passion projects);		
Schellinger (2021) United States	This study examined integration by considering the intersection of engineering principles with science curricula. More specifically, they wished to investigate how 'to effectively engage students in engineering with science to examine if this integration lives up to its potential' (p. 33).	Case Study (n=8 tasks; Observations)	Completion of 8 tasks by 5th Grade Learners (N=20)	The authors used Moore et al.'s (2014) definition of STEM to frame their initial discussions i.e., 'STEM integration as the merging of multiple disciplines in a class, unit, or lesson to deepen students' conceptual knowledge through contextualization in another discipline' (p. 33). When discussing the integration of two of those disciplines (science, engineering) the authors offer this definition: a curriculum, unit, lesson, or task centered on an engineering challenge, which serves as the context to make the underlying scientific phenomenon more relevant to students (p. 34).	The authors noted that in completing the tasks, the students moved from 'doing science' to 'doing engineering'. However, 'doing school' activities (e.g. filling in a worksheet) often required the students to move away from 'productive epistemological framing' because the students went 'off script' (see p. 47). The authors also noted that the 'trial and error' approach often associated with the beginning of the engineering process was at odds with the teacher's hopes that such an approach would encourage the students to apply their knowledge of scientific phenomena (see p. 51; battery circuit).	(i) small sample size, (ii) selection bias (teacher appeared highly motivated to integrate engineering into her science lesson), (iii) generalisability concerns (unclear if the teacher involved was a general elementary school teacher or a specialist science elementary teacher, (iv) researcher bias (researcher was familiar with the school setting)	Journal Article (Peer Reviewed)
Schugar (2017) United States	This study involves a secondary analysis of how US NAEP (National Assessment of Educational Progress) reading comprehension scores are impacted by particular factors. One of the factors is 'cross-curricular reading', which researchers constructed from individual items in the student survey that accompanies the comprehension items. This component/factor was built from	Secondary Data Analysis (NAEP scores analysed using hierarchical linear modelling)	N=165,000 fourth graders	This study examines 'cross-curricular' reading as one of several factors that impact students' reading success at the fourth grade level. Models of integration are not cited.	Relevant findings/outcomes include: (i) Comprehension for informational text was significantly lower than the score for overall comprehension or narrative text comprehension, (ii) Students who qualify for free and reduced meals (FARMS) scored significantly lower on comprehension for informational text, (iii) Based on the within school model, every increase of 1 standard deviation in the frequency with which students engaged in cross-curricular reading was matched	(i) NAEP relies on student report of practices, (ii) the 'cross-curricular reading' variable relies on measures that do not specifically measure this construct	Journal Article (Peer Reviewed)



responses to questions on the frequency of reading texts such as paperbacks, soft cover books, puzzle books or magazines for science, social studies or history.

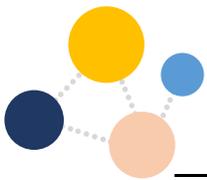
with a 1.10 point increase in informational text comprehension; this effect was not associated with FARMS status (iv) Based on the between school model, a 1 standard deviation increase in the frequency with which cross-curricular reading materials were used was associated with an increase of 3.46 points in comprehension; The authors conclude that the use of cross-curricular reading materials (reading across the curriculum) are clearly associated with increase in reading comprehension

Sen (2017) Turkey	The purpose of this study was to identify and examine the views of middle school mathematic teachers on the integration of science and technology in mathematics instruction.	Case Study (Interviews)	In-Service Teachers (N=12; middle school mathematics teachers)	An explicit model of integration was not described. Instead the authors discussed why they considered it 'necessary' to integrate mathematics, science and technology.	The teachers involved in the study agreed that mathematics can be related to a number of disciplines but that it can be most easily related to science (and in particular, physics). However, some participants argued that 'other disciplines use mathematics' and, as a result, mathematics should still be taught as a distinct subject. This, according to the participants, would ensure that students get the foundational knowledge they need in order to use maths in other subjects. Regarding the integration of technology and mathematics instruction, participants were broadly positive as the integration of these subjects was time efficient, allowed for visualisation of abstract topics and supported effective teaching practice for certain topics (e.g. fractions, geometry, patterns).	(i) Limited data gathered	Journal Article (Peer Reviewed)
Shin (2022) Korea	This study examined seven Korean elementary teachers' experiences with the government designed curriculum (2015) which has prioritised curricular integration. The study examined teachers' experiences and views on curricular integration from both the macro (institutional and systemic) and micro (individual and classroom) level.	Qualitative (Interviews)	In-Service Teachers (N=7)	The author offered this definition of integration: Curriculum integration can be defined as a design where different related disciplines provide the basis for the topics which are relevant to a student's life (Beane 1997; Etim 2005; Fraser 2000); p. 50. No other particular model of CI was emphasised.	Key themes that emerged from the qualitative data included the following: Autonomy, Disconnection from the education system (i.e. only relevant for lower elementary system, new assessment approaches needed), Steps to support CI. Autonomy was seen as a key factor in supporting effective CI.	(i) small sample size, (ii) some further detail on data analysis would have been beneficial	Journal Article (Peer Reviewed)

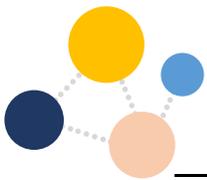


Shumacher (2012) United States	This study examined how 7 educators in one school perceived and practice the integration of environmental education; it deliberately included teachers who both opposed and supported this integration.	No overall design stated - qualitative/phenomenology (semi-structured interviews)	N=7 educators (n=6 teachers, n=1 administrator) from 1 private school in Atlanta, Georgia	No model of curriculum integration is cited. The study focuses on the integration of environmental education; the form of this integration is not given conceptual treatment.	Characteristics influencing EE integration included: the level of support offered by colleagues and school leaders, including the presences of EE 'cheerleaders'; having freedom within the curriculum to explore EE; the availability of appropriate resources in the school environment; having personal incentives/values that promote the teaching of EE; the presence of barriers including, teacher comfort with the subject, challenges in taking students outside, a lack of teacher interest, the influence of politics (e.g. belief in whether climate change was a real concern); the value placed in EE by administration.	(i) Small sample size, (ii) highly specific context	Journal Article (Peer Reviewed)
Simmons (2015) United States	This study examined the perceptions of elementary school teachers regarding the impact of a professional development programme on music integration in an International Baccalaureate (IB) school. Following the collection of qualitative, interview data with colleagues, the author designed a 3-day PD programme to support their generalist colleagues with music integration	Case Study (Interviews, Surveys [Arts Integration Partnership Evaluation], Focus Group)	In-Service Teachers (N=10)	The author offers a range of definitions to explain the term 'music integration' but does not appear to elevate any one definition. The author does note that IB schools undertake a Program of Inquiry (POI) approach to instruction which should support the integration of music education in these contexts. According to the author, POI is 'a pattern of instruction based on six trans-disciplinary themes and central ideas that support inquiry-based learning (p. 18). However, the author does not discuss this approach in any great detail.	Key themes that were constructed from the qualitative data gathered included: Music integration supports instructional delivery, engagement and IB curriculum; Teacher collaboration between core and specialist teachers needed for music integration; PD encourages collaboration. As a result of the data gathered, the author designed a 3-day PD programme for their colleagues.	(i) sample size, (ii) context (generalisability due to context and role of generalist/specialist teachers), (iii) potential researcher bias	Doctoral Thesis
Smith (2016) United States	Students in the experimental group engaged in dance-integrated geography/history (anthropology) lessons on Ancient Egypt. For example, they enacted - through dance- the geographical features of the greater Nile region.	Intervention; two intact groups; pre/post-testing using the textbook chapter text and adapted attitudinal survey on enjoyment of social studies; field notes (qual) completed after each lesson	Sixth Graders (N=56)(Two classrooms)	Dance/movement was integrated with the content for an integrated social studies unit. Anthropological perspectives on culture strongly informed the work. The typically cited models of integration were not invoked.	At post-test, students in the intervention group scored higher on the chapter test $t(53) = 8.43, p < .05$; there was no difference in attitude to social studies $t(52) = .003, p = .96$; Analysis of journals indicated that students expressed positive views towards dance (notably, journals were not conducted with the regular instruction group) but there were also negative sentiments "It's kind of hard	(i) This study drew on intact groups; though measures of knowledge were reported as being the same in both groups at time 1, a larger study would be needed for greater causal claims, (ii) researcher effects are also very likely	Journal Article (Peer Reviewed)

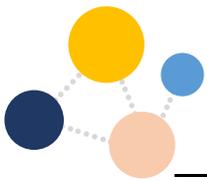




					for me to learn anything this way" (Female. White.)."	given the researcher enacted the dance unit	
Smith-Gayle (2014) United States	This study involves a secondary analysis of state testing data on ELA scores, to examine the impact of integrated teaching on middle school boys' performance.	Ex post facto quantitative analysis of reading assessment data (New York State ELA test scores)	Middle school boys (N=3448) (grade 6,7,8) who completed NY state reading assessments in the period 2007-2012; n=2318 (67%) undertook the integrated curriculum, drawn from two schools, n=1130 (32%) undertook 'traditional' curriculum, drawn from two schools;	Integrated curriculum is defined as grouping "subject areas through content by relating topics in an effort to motivate students and make connections among central topics; an emphasis on projects, thematic units, and sources that go beyond textbooks provides a rich, meaningful, and comprehensive learning experience" (p.9), citing Barry (2008).	There was no significant difference in academic achievement between integrated and traditional schools ($Z = -.262, p = .793$). Analysis of sub-groups indicated that there were no significant differences at individual grade levels based on traditional v integrated instruction. Generalised linear mixed models indicated no difference between groups, though this model was likely confounded by unmeasured variables not available due to the nature of the public data set.	(i) Non-randomisation of sample, (ii) reading-only outcome measure (appropriateness), (iii) modelling does not take full account of other variables nested in classes/schools - more advanced modelling procedures needed to address the full complexities of the data, (iv) limited information provided on the nature of the integrated teaching (and how it differed to 'traditional' teaching) in selected schools	Doctoral Thesis

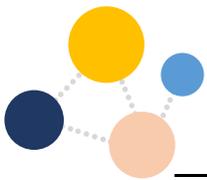


<p>Snyder (2014) United States</p>	<p>Using a quasi-experimental approach, this study examined the impact of the Supporting Arts Integrated Learning for Student Success (SAILSS) model on student achievement three years after its introduction to a struggling 'Tier I' school in the United States.</p>	<p>Quasi-Experimental (Treatment Schools.; Comparison Schools.; state and local standardized testing, School-level Environment Questionnaire [SLEQ], Arts Integration: Classroom Observations for Middle Schools [AICOM], arts integration logs and researcher-designed parent, student, and teacher surveys)</p>	<p>Schools (n=2; Treatment: 510 students approx., n=1 school, Control: 661 students approx., n=1)</p>	<p>No particular model of integration was invoked in this article. However, brief references were made to key theorists in the field such as Burnaford et al. (2007). The authors also cite Erickson (2000) to justify their statement that 'natural, meaningful connection among one or more art forms and one or more subject areas to help students master significant content and/or skills in both' (p. 5).</p>	<p>For all grade levels (Grades 6-8), the overall percentage of students who scored Proficient or Advanced from the Treatment school was statistically higher than the percentage of students from the control school to receive the same grades (p<0.01). Regarding Reading, the effect size representing the improvement in standardised test scores in the Treatment school from 2009 to 2012 for Grades 6, 7 and 8 respectively was 0.29, 0.53 and 0.24. For standardised test scores in mathematics, the effect sizes calculated for the improvements in test scores from 2009 to 2012 were 0.41, 0.48 and 0.07 for Grades 6, 7 and 8 respectively. An ANOVA found that time did not have any impact on student scores. In addition to increasing student achievement on state-wide assessments, implementing this arts integration model positively correlated with a 77% decline in discipline referrals, and overall positive change in school climate based on teacher, staff, student, and parent perception.</p>	<p>(i) sample (generalisability of the experiences of specialist middle school teachers to generalist teachers), (ii) intact groups</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Speldewinde (2022) Australia</p>	<p>This study offers a new conceptualisation of an integrated approach to STEM teaching for young children. The paper discusses how this conceptualisation is derived from the author's ethnographic fieldwork data.</p>	<p>Multi-Site Case Study (Ethnographic Fieldwork, Observations)</p>	<p>Bush Kinder Sites (N=4)</p>	<p>According to the author, STEM education is defined as an 'integrated approach to teaching all four disciplines in equal amounts' (p. 445).</p>	<p>The author (using work by Forbes et al., 2021, Wiedel-Lubinski, 2019 and their own fieldwork data) constructed a highly specific, 5-step model for supporting STEM integrated activities in outdoor contexts: Phase 1: Identifying and understanding, Phase 2: Examine and Research, Phase 3: Plan and Design, Phase 4: Creation, Phase 5: Assessment and Evaluation. In each of the phases, the teacher has a key role in progressing the children's learning.</p>	<p>(i) generalisability (model was created for a very specific context), (ii) extremely limited range of data sources, (iii) researcher bias, (iv) inadequate discussion of analysis techniques</p>	<p>Journal Article (Peer Reviewed)</p>

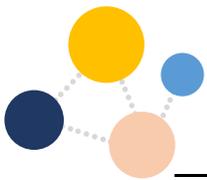


<p>Stapp (2020) United States</p>	<p>This study examines how pre-school teachers enacted nutrition-integrated lessons in their classrooms. Qualitative analyses of the data outline barriers and benefits of the lessons.</p>	<p>Qualitative - no overall design cited (focus groups; field observations; lesson feedback forms)</p>	<p>Early childhood teachers (n=10); Pre-K4 students (n=132); pre-schools (n=3)</p>	<p>The literature on curriculum integration is not cited in this paper. The study relies on the integration of nutrition-oriented content into subjects like science and English language arts.</p>	<p>Findings are reported under three main themes: (i) Preconceived experiences of the unknown v. experienced reality: teachers demonstrated a lack of self-efficacy for nutrition instruction in the initial focus groups but were nonetheless willing to take part; afterwards many reported that students benefitted from the experience, (ii) Promoting buy-in and engagement through hands-on learning experiences: Students were largely engaged during these lessons, supporting student learning/recall, (iii) Manifestation of perceived prioritisation: In pre-focus groups, teachers dwelled on the lack of time they had during the day to fit in new instruction; this led to shortening of the nutrition-oriented lessons or not teaching them at all in some cases;</p>	<p>(i) Somewhat limited information provided on how subjects were integrated, (ii) outcome data not measured, (iii) no control group, (iv) relatively small sample size</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Swan (2013) United States</p>	<p>This study investigated the 'preparation for future learning' (PFL) approach, which has similarities to problem-based learning. In this approach, students encounter a scenario or problem before receiving more formal instruction on how to address the problem. More specifically, students encountered the problem relating to world water shortages and allocations in social studies, before learning about proportional allocation in mathematics and subsequently applying this knowledge in science (water cycle problems) and language arts (persuasive writing and oral presentations which communicate new learning). Thus, integrated learning happens in a consecutive rather than concurrent manner. Students receiving PFL instruction were compared to those who did not.</p>	<p>Quasi-experiment (researcher-designed data literacy assessment; written student reflections; teacher interviews)</p>	<p>Seventh graders (N=576) drawn from two schools; n=114 took place in the intervention</p>	<p>The authors refer to the PFL instantiation in this study as an 'interdisciplinary data literacy curriculum'. Curriculum integration is not conceptualised or defined in this study.</p>	<p>Students in the intervention group outperformed students in the non-intervention group (MD =2.703, SE = 0.282, p < .01). Analysis of individual items in the pre/post assessment revealed varying improvements from time 1 to time 2. Students reported benefits of the sequenced, integrated teaching in qualitative data; teachers reported benefits for student learning</p>	<p>(i) Uneven numbers in intervention (n=114) and non-intervention (n=462) groups, (ii) the data is nested within classes and schools, therefore more advanced modelling/statistical analyses may have better accounted for the data (including differences between schools), (iii) there is a lack of detail on the provenance of the unit, (iv) limited information on the activities completed by the control group and the fairness of the comparison</p>	<p>Journal Article (Peer Reviewed)</p>

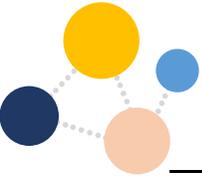




<p>Talbert (2019) United States</p>	<p>Two studies are involved in this dissertation which explored the relationship of background knowledge, reading comprehension, and content learning on student progress and learning. Study 1 involves an experimental design that examines the effects of teaching inferential strategies while building knowledge using informational text. Study 2 is a meta-analysis that aims to determine if the practice of integrating science and literacy instruction is associated with higher effect sizes for measures of literacy and science achievement.</p>	<p>Study 1: Experimental Design involving three conditions and the collection of pre-post test data; Condition 1: Reading Detectives Inference Instruction, Condition 2: Explorers Content Knowledge Instruction and, Condition 3: business-as-usual control group (Researcher-created measure of reading comprehension; standardised measure of reading comprehension [Gates-MacGinitie Reading Test]; researcher-created measure of disciplinary content); Study 2:</p>	<p>Study 1: 5th Grade Learners (n=94), Study 2: Meta-Analysis (n=32 studies)</p>	<p>The author discusses integration in terms of two disciplines becoming 'increasingly interwoven' (p. 3). Discussions on curricular integration generally invoked terminology and conceptualisations associated with interdisciplinary instruction. When considering literacy-integrated instruction across a range of curricular areas, the author states that both disciplinary literacy and content area reading are valuable conceptualisations of integration that should be advocated in classrooms.</p>	<p>Study 1: Both intervention groups performed better on a researcher-created measure of reading comprehension when compared to a business-as-usual control, though not on a standardized measure of reading comprehension (Gates MacGinitie Reading Comprehension, $p=.544$). There were no statistically significant differences between the content knowledge and inferential intervention groups on a measure of content learned, indicating either method of strategy instruction was effective for knowledge acquisition. The effect sizes calculated indicate that those in the inferential intervention group may have had a slight advantage on performance on content knowledge group. Study 2: Results from 32 studies show an overall weighted mean effect of 1.04 for science outcomes and .245 for literacy outcomes - evidence that the practice of integrating science and literacy instruction is effective.</p>	<p>Study 1: (i) learners in the study were all 'average' or 'above average' readers (sampling/generalisability biases), (ii) relatively small sample size, (iii) intervention length was quite short (thus making it unlikely that the standardised test scores would ever improve in the study). Study 2: (i) publication bias, (ii) number/type of studies included</p> <p>Doctoral Thesis</p>
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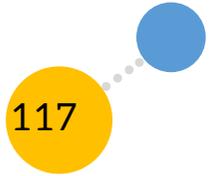
<p>Tam (2021) Hong Kong</p>	<p>This paper examines how teachers in Hong Kong went about integrating process drama and play-based approaches with the broader curriculum.</p>	<p>No overall design stated; similar to a case study (observations of teaching; interviews; documentary analysis of curriculum planning documents)</p>	<p>Kindergarten setting in Hong Kong (N=1)</p>	<p>Integration is focused on drama and play in this study, with minor references to other curriculum areas such as literacy. No conceptual model of integration is provided.</p>	<p>Findings are reported under several headings: (i) Learning through drama - learning emerges naturally: learning through drama does not follow a linear pattern but emerges naturally; it includes social and cognitive benefits, attributable to the playful and experiential nature of the approach; memory for story/drama was supported through revisiting content through multifaceted approaches (ii) Pre-drama teaching: Precursor to complex drama learning: two main types of teaching were involved before engaging in more complex drama - 1: teaching the tools needed (e.g. story frames, rules for games), 2: teaching subject knowledge in a planned, direct and explicit manner (iii) In-drama teaching/learning: imaginative problem-solving and elaborate drama-building: teacher in role was helpful to engage students with the dramatic world; drama-prompted free play helped children to engage in more elaborative ways on the dramatic focus (iv) Post-drama learning/teaching: Savouring, enhancement and extension of drama experience: debriefing after drama was important; serendipitous learning was embraced</p>	<p>(i) Small sample size, (ii) Limited information on actual curricular planning/integration, (iii) potential researcher effects</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Tank (2014) United States</p>	<p>This study examined the integration of STEM teaching and learning in elementary classrooms with the reading of nonfiction children's literature. This doctoral research investigated how this particular approach to integration impacted student learning in each of these disciplines. Particular attention was paid to the impact of science and engineering integrated activities on student outcomes.</p>	<p>Mixed-Methods research study involving a quasi-experimental pre-post-test design intervention with a control group as well the collection of qualitative data from students (FOSS Landforms Unit Pre-Post Assessment; EiE Stick in the Mud Unit Assessment; Teacher-developed Reading</p>	<p>5th Grade Learners (n=120); 4 classes; Study 1: Science (n=27) vs Science+Reading (n=27), Study 2: Science+Engineering+Reading (n=24) vs Science+Engineering (n=26)</p>	<p>The author used the terms inter-, multi-, and trans-disciplinary interchangeably throughout the dissertation. The study relies on the idea that the importance of being able to read, interpret, and produce texts as fundamental practices in science and engineering justifies the idea that literacy integration with STEM instruction should be explored.</p>	<p>SCIENCE ONLY: The addition of the integrated nonfiction science reading unit did had a significant effect on pre and post-test science content assessment performance (Cohen's d=0.28). The author noted that in their analysis of the interview data that the treatment students were more frequently able to recall science concepts in their interviews than the control students. While both the control and treatment group improved on their post-test performance, the results from the statistical analysis of the reading content assessment found a non-significant effect of the treatment on</p>	<p>(i) intact groups, (ii) validity of measures used, (iii) gaps in the baseline data gathered means that some interpretations may not be fully appropriate, (iv) explanation of work undertaken in the treatment/control conditions were unclear.</p>	<p>Doctoral Thesis</p>

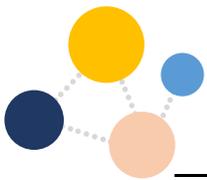


Comprehension and Vocabulary Assessment; Student Interviews; Document Analysis (Student notebooks)

students' learning in reading for those students in the science condition.

SCIENCE & ENGINEERING: For the science content assessment measure, the treatment scored higher on the post-test, but that was not likely due to a significant effect on student learning caused by the treatment, or the integration of nonfiction science books. Treatment students who participated in the integrated nonfiction unit had increased learning in engineering as seen by their higher average notebook scores, especially for the open-ended notebook tasks, and by their ability to more frequently recall and make connections between engineering concepts in their student interviews. The treatment students from the engineering+science+reading condition did significantly outperform the control students on the reading content assessment.





**Trent (2018)
United States**

This study examined the impact of an arts-integrated teaching and learning history/ geography unit ('We are Wyoming') on students' academic achievement and engagement.

Action Research (Field Notes, Artefacts [student work samples], rubrics)

4th grade learners (N=696)

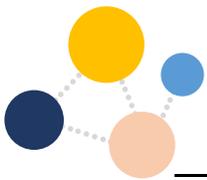
This paper used the following definition from Robinson (2012) to define arts integration: 'a curricular connection process that collaboratively engages all to promote learning through and with the arts' (p. 371). The authors also stated that a 'co-equal' art integration model was applied in this project (without any further citation or reference to support this assertion).

Some of the students' work (n=40) in the 'County Quarters' project was evaluated on a 4-point scale (unsatisfactory-developing-proficient-exemplary) using Social Studies and Fine & Performing Arts Standards. The overall average score for students was 2.37 on the 3-point scale when combining and averaging scores from both content areas. Students scored slightly higher on the fine and performing arts standards (average score 2.48) than they did on the social studies specific standards (average score 2.26), but clearly, on average, exceeded the proficient level in both areas. For the 'Wyoming Timeline' lesson, Students scored an average 2.29 on the Social Studies items, 2.26 on the Language Arts, and 2.18 on the Fine and Performing Arts items, with an overall average of 2.24 across the three-point scales. For the 'Wyoming Artists' lesson (where students had to respond in writing to contemporary work made by Wyoming artists), students were evaluated on multiple language arts criteria as well as on Arts standards specific to observing, describing, interpreting, and expressing personal preferences for artwork. Students averaged 2.32 on language arts items and 2.2 on the arts components. For the final 'Wyoming Watercolour' lesson (which targeted standards in Fine & Performing Arts and in Social Studies), the sampled students scored an average 2.22 across evaluated criteria in both subject areas (on the 3-point scale), scoring an average 2.28 in the arts and 2.16 in the social studies.

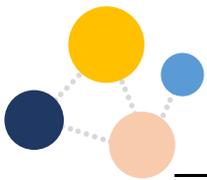
(i) generalisability (e.g. researchers rather than delivered a 2-day arts-integrated unit. disadvantaged students may have been over-represented in the sample), (ii) limited range/type of data, (iii) 'informal' interviews were used as a data source (rigour of analysis may be somewhat suspect), (iv) short intervention, (v) the 'systematic' sampling of the 40 students whose work was evaluated using rubrics was not clearly explained.

Journal Article (Peer Reviewed)



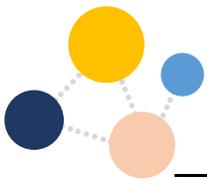


<p>Trinter (2021) United States</p>	<p>Six middle grade teachers worked with two teacher educators over the course of ten months. The teachers used a backward design model to design instructional units, which emphasises learning goals first. Units focusing on social issues were developed (clean water and organism dependence; race/identity/equity) and enacted.</p>	<p>Exploratory embedded single case study (semi-structured interviews; video-recorded bi-weekly planning meetings; focus groups; field notes)</p>	<p>Middle grades teachers (N=6)</p>	<p>Teachers in this study planned interdisciplinary curriculum units. Limited attention is given to models of curriculum integration.</p>	<p>Teachers encountered 'productive struggle' in planning interdisciplinary units, but this struggle was worthwhile. Challenges and affordances are reported under a number of themes: (i) Initial Struggle: Teachers encountered challenges in shifting from activity-oriented planning to student outcome oriented planning; this was a large change in practice, (ii) Transition from Struggle to Productivity: Teachers began to realise the value of this form of planning</p>	<p>(i) Small sample size, (ii) student outcome measures not included, (iii) very particular context with high levels of researcher support</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Tucker (2017) United States</p>	<p>This research examined the effects of arts-based instruction on student literacy achievement for 5th grade learners. Students received an arts-based literacy intervention (delivered by the researcher) three times a week for number of weeks.</p>	<p>Action Research involving an experimental design (Pre-Post Assessment Data [Researcher-Designed assessment of literacy skills] with no control; researcher-designed survey of students' attitudes about reading/literacy]</p>	<p>5th Grade children (N=10)</p>	<p>No general definition of integration was provided. The author offered a definition of arts integration based on the work of Silverstein & Layne (2010, p. 1) which asserts that arts-based integration is "an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both". Arts-integration is considered by the author through the theoretical lens of Gardner's Multiple Intelligences theory (2011).</p>	<p>An increase in student achievement was noted in the researcher-designed assessment of literacy skills i.e. 8 out of the 10 students showed some improvement between pre- and post-assessment.</p>	<p>(i) researcher bias (researcher administered the intervention to a group of children known to them), (ii) Selection bias (students were selected for the intervention because they were reading below expected grade levels - any extra intervention regardless of form may have caused an improvement), (iii) insufficient control for potential confounders, (iv) inadequate description of intervention</p>	<p>Doctoral Thesis</p>

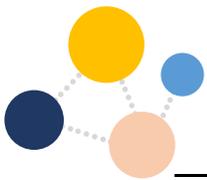


<p>Tytler (2021) Australia</p>	<p>This study reports outcomes related to a larger, longitudinal project that project that is investigating the conceptual, curricular and pedagogical principles that may govern interdisciplinary mathematics and science instruction. This particular paper describes the interdisciplinary structure integrated STEM units of work (with a strong emphasis on the synergies between Maths and Science instruction). The authors later state that this represents a 'temporal' model of interdisciplinarity (see Tytler, 2019) 'which recognises the need for disciplines to interact at micro-, meso- and macro scales, in this case to ensure the interactions at the micro-(moment by moment) and meso- (within, and across lessons) attend to macro-considerations of support for longer term progression in concepts and practices' (p. 1942).</p>	<p>Design-Based Research (Case Study)</p>	<p>Australian elementary schools (N=4); data was derived from a range of teachers and learners in these schools.</p>	<p>The authors were investigating the value of an interdisciplinary approach in enriching mathematics and science learning among primary aged learners. This approach was guided by socio-cultural perspectives (e.g. Vygotsky) and Pierce's (1931/1958) pragmatist view of meaning making. No particular model of integration was invoked by the authors beyond their consistent use of the term 'interdisciplinary' but they did note that the design of interdisciplinary units of work was guided by the 'complementarity of concepts' (p. 1929) in the Australian science and maths curricula (e.g. Ecology [Science], Data Modelling [Maths]).</p>	<p>Three case studies were presented to summarise the data gathered, with particular attention paid to the content addressed and the pedagogies employed by teachers [see 'Pedagogical Approaches' for full details]: CS1 (Grade 1 Astronomy): Topics addressed included shadows, light, dark, length, formal/informal units, graphing, geometry, angles; CS2 (Grade 1 Ecology): Topics addressed included living/non-living objects, plants/invertebrates, graphing, tallies; CS3 (Grade 2 Force & Motion): Topics addressed included time, weight, force, motion, decimals, time, number, gravity, symmetry. Authors noted that in addressing the instructional sequences that it was easier to 'design from within science topics, then incorporate mathematics' (p. 1943).</p>	<p>(i) write up of study is inadequate and required more detail in all areas (part of a large longitudinal study), (ii) Does not address how this 'STEM; intervention aligns with the subjects of engineering and technology</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Uyar (2018) Turkey</p>	<p>This study aimed to develop pre-service social science teachers' understanding and implementation of elementary school science in Turkish classrooms.</p>	<p>Case Study (Interviews, Observations, Document Analysis [Reflective Journals])</p>	<p>Pre-Service Teachers (N=25)</p>	<p>The authors emphasise two key sources in their descriptions of an inter-disciplinary approach to integrated curricula. Using work by Jacobs (1989, p.8), they define the interdisciplinary approach as "a curriculum approach that applies the language and methodology based on more than one discipline to examine a theme, issue, problem or an experience". In line with Drake (2007) and Beane (2001) they note that instruction in an interdisciplinary approach simultaneously integrates the knowledge, skills and perspectives of different</p>	<p>Pre-service teachers exhibited a number of misconceptions at the start of the study, particularly around the nature of science. By the end of the study, some (but not all - particularly regarding definitions of theory, law, hypothesis) of these misconceptions had been addressed and the students were more confident in making interdisciplinary links to support their future work as teachers e.g. periodic tables, maps etc. Positive features of the intervention included: use of audio-visual materials and interesting examples of activities related to different scientific fields. Factors that pre-service teachers' identified as inhibitors for their future work in integrated science with social studies included: low level of readiness, physical classroom</p>	<p>(i) inconsistent approach to sampling (moved between convenience and purposive sampling), (ii) researcher designed materials/lesson plans (validity, reliability), (iii) researcher bias possible (role of researcher is somewhat unclear), (iv) inadequate description of the intervention</p>	<p>Journal Article (Peer Reviewed)</p>

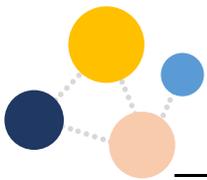




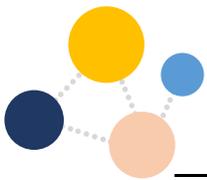
				disciplines while also establishing explicit 'connections' between subjects.	environment, unclear resources, and instructions limiting imagination.		
Vacca (2022) United States	Art classes ran once a week for six weeks; maths ran three times a week for two weeks. Teaching/research was conducted remotely during the COVID19 pandemic.	No overall design stated- qualitative (comic artifacts, interviews)	middle school teachers (n=2); seventh graders (n=33)	No model of integration is cited. The study involves the integration of three strands: art (creating comic books), mathematics (data reasoning based on a survey of the students on friendship patterns) and social-emotional learning.	Teachers varied in their beliefs about STEAM and the supports they needed to implement it successfully. Age, professional training and teaching experience did influence teachers' beliefs about the characteristics of STEAM. Themes related to early childhood educator beliefs about STEAM education included: (1) Focus on products (participants saw STEAM related activities to be very task orientated and wanted a 'product' to use immediately), (2) Priorities for instruction (some teachers queries the necessity of some STEAM tasks i.e. they did not correlate with what should have been learned but they were enjoyable at least), (3) View of children (concerns about behaviour management), and (4) Management (times, materials), .	(i) Small sample, (ii) highly specific form of integration, (iii) extensive planning time that might not be replicable	Conference Proceedings/ Papers



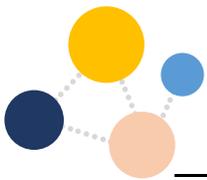
<p>Vallera (2015) United States</p>	<p>Students in the treatment group of this study partook in a ten-day agriculture/STEM integrated curriculum, including a trip to an agricultural education centre. This integrated curriculum included challenge-based, technology-integrated curriculum and was enacted by the regular classroom teacher (but developed by the researcher). The control group did not receive agriculture-related instruction.</p>	<p>Quasi-experiment using design-based research (knowledge test of science/technology/engineering and agricultural literacy [KnowASTE, based on combination of items from other standard measures]; attitude measure on science/technology/engineering and agricultural literacy [ThinkASTE, based on combination of items from other standard measures]; analysis of project-based performance tasks)</p>	<p>Fourth graders (n=95); treatment (n=42), control (n=38); from 4 classrooms (n=4 teachers) in (n=1) school</p>	<p>Jacobs' (1989) definition of interdisciplinary curriculum is used.</p>	<p>Increases in knowledge and positive attitudes were evident across all analyses of measures: (i) Overall knowledge: ANOVA revealed significant difference between groups $F(1, 78) = 18.57, p < .001$, partial $\eta^2 = .192$; and from pre to post-test $F(1, 78) = 17.91, p < .001$, partial $\eta^2 = .187$, favouring the treatment group; ANCOVA analysis controlling for pre-test scores maintained this difference, $F(1, 77) = 38.91, p < .001$, partial $\eta^2 = .336$, (ii) Analysis of sub-scale scores of science, technology/engineering and agriculture scores, controlling for pre-test scores also revealed significant differences between groups (MANCOVA: Wilks' $\lambda = .644, F(3, 75) = 13.834, p < .001$), (iii) Overall attitudes/beliefs: A significant difference between groups was also found in ANOVA analysis $F(1, 78) = 26.41, p < .001$, partial $\eta^2 = .253$; with a difference from pre to post-test also evident, $F(1,78) = 6.96, p = .010$, partial $\eta^2 = .082$; ANCOVA analysis again revealed a difference while controlling for pre-test scores $F(1, 77) = 17.88, p < .001$, partial $\eta^2 = .188$, (iv) Analysis of sub-scale attitudes/beliefs in science, technology/engineering and agriculture: MANCOVA analysis indicated significant differences on the individual items when controlling from pre-test scores (Wilks' $\lambda = .781, F(3, 75) = 6.991, p < .001$)</p>	<p>(i) Use of intact groups, (ii) treatment group did not receive similar content instruction - potentially unfair comparison</p>	<p>Doctoral Thesis</p>
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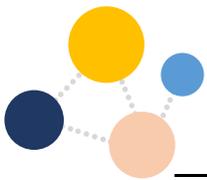
van't Hoof (2012) United States	This article provides an overview of the middle school 'Thinking with Data' curriculum which aims to guide teachers in their efforts to teach data literacy across multiple subject areas. The study compared the impact this interdisciplinary curriculum had on students' data literacy skills compared to those who received a more traditional curriculum.	Experimental Design with control (Pre-Post data gathered [researcher designed data literacy assessments], subject-specific test scores [science, mathematics])	7th Grade students (N=576; across 2 schools)	No model of integration is invoked when discussing the teaching of data literacy beyond stating that this is a topic that should be taught using 'cross-disciplinary approaches'.	Students in the treatment condition (n = 114) had a gain score that was 3 points higher on a 15-point test of data literacy than comparable students who did not engage with the TWD materials (n = 462). This difference was statistically significant with a very large effect size, $d = 1.24$. MANOVA analysis indicated that approximately 31% of the difference in total gain scores between the conditions can be attributed to the 'Thinking With Data' curriculum. Learning gains in discipline specific science and maths assessments were noted e.g. Science Scores, School 1: $d=1.36$, School 2: $d=.56$	(i) imbalanced sample sizes i.e. Treatment: $n=114$, Control: $n=462$, (ii) generalisability of school context i.e. four teachers taught data literacy integrated with their individual subject (rather than all subjects being taught together by one teacher), (iii) pre-test scores indicated that the students involved in the study may not have been directly comparable, (iv) imprecise statistical analysis which casts doubt over the results obtained e.g. the assumptions for homogeneity of variance and covariance were violated, test instruments were not treating consistently in terms of administration or analysis	Journal Article (Peer Reviewed)
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Viñas (2021) Spain	<p>This study examines the critical events associated with the delivery of an integrated unit of work on the topic of symmetry involving music, dance and mathematics.</p>	<p>Action Research (Interviews, Observations)</p>	<p>6th grade students (N=30)</p>	<p>While the authors offered a very good overview of the concepts and key readings associated with the field of curricular integration, the study itself did not appear to align to any particular framework or model.</p>	<p>Analysis of the five 'critical events' associated with this study indicated that students were required to 'switch' between different disciplinary languages as they progressed towards the final task associated with the unit (performing their musical composition) e.g. when they switched from mathematical to musical language, from musical to visual language and, finally, from musical or visual language to choreography (p. 240). Use of an open-ended task that drew on the knowledge of multiple disciplines lead to the following (based on authors' analyses): greater awareness of learning; the development of critical and logical thinking when dealing with situations that demand a solution; stimulation of creativity to implement new procedures and resources for resolving conflicts; and an improvement in the ability to work together in a team. (p. 241). However, some students found it difficult to cope with the challenges associated with critical events.</p>	<p>(i) Key contextual factors likely had an impact on the unit's success e.g. learners had a high level of musical knowledge thanks to their prior educational experiences, (ii) range of data gathered</p>	<p>Journal Article (Peer Reviewed)</p>
Vlcek (2018) Slovenia & Czech Republic	<p>This study examines the potential for integrating PE with geography in the Czech Republic and Slovenia. This is achieved through expert analysis of the curriculum in both countries and the completion of a small-scale survey by teachers from each jurisdiction.</p>	<p>Comparative documentary analysis / survey (questionnaire for teachers)</p>	<p>Teachers (n=64) took part in the survey; experts (n=2; one geography, one PE) from each country supported the examination of curricular documents</p>	<p>This study is firmly located within the realm of interdisciplinarity; most references to the literature refer to the synergies between two disciplines. A variety of scholars are cited, including Jacobs (1989), Klein and Newell (1998), Tabulawa (2017), Drake and Burns (2005).</p>	<p>(i) Policy/curricular analysis: integration of PE and geography is emphasised in both Slovenia and the Czech Republic, but the curricular structure is different in both countries; there is scope to integrate both, (ii) teacher surveys indicated that integration is not being implemented in practice as frequently as it could; almost half of teachers did not have experience in integration</p>	<p>(i) Very small sample size for a survey, (ii) likely other confounding factors that explain the results cannot be accounted for, (iii) self-report of teachers</p>	<p>Journal Article (Peer Reviewed)</p>

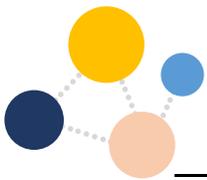


<p>Volk (2017) Slovenia</p>	<p>This study examined how the use of tablets supported the integration of maths with learning science and the Slovene language, drawing on concrete, visual and abstract representations. The topics of time and orientation (maths) served as the basis for the integration.</p>	<p>Experiment without randomisation; quasi-experiment (researcher-designed assessment addressing a three-level taxonomy - conceptual knowledge, procedural knowledge, problem-solving; observation; field notes)</p>	<p>Schools/classes (N=12): control (n=6), treatment (n=6); n=124 students in the treatment group, n=135 in the control group</p>	<p>This study examines how tablet use (technology integration) can support the cross-curricular application of mathematics knowledge. The works of Jacobs (1989), Fogarty (2009) and Boix Mansilla (2010) are cited in supporting the need for cross-curricular teaching. The following definition of interdisciplinary learning is offered: "interdisciplinary learning is thus "defined by the integration of multidisciplinary knowledge across a central program, theme or focus" (Ivanitskaya, Clark, Montgomery, & Primeau, 2002, pp. 95)". The study takes place in the context of a reformed Slovenian curriculum that provides more autonomy for teachers to teach in a cross-curricular manner.</p>	<p>Students in the treatment group scored significantly higher at the second taxonomy level (procedural knowledge; U= 5132.000, 2p =0.000, r=0.33) and third taxonomy level (problem solving; U =6439.000, 2p = 0.001, r=0.30). There was no significant difference at the first taxonomic level (conceptual knowledge), which was predicted by the authors. Qualitative data indicated that students found tablets more engaging to learn.</p>	<p>(i) Non-randomisation of students, (ii) little attention given to the use of nested data/intact groups in the analyses</p>	<p>Journal Article (Peer Reviewed)</p>
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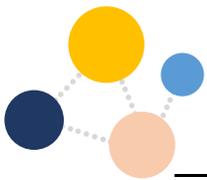


Wendell (2014) United States	<p>This study examined the discourse of pre-service teachers engaged in engineering design tasks based on children's literature. It focused on their epistemological framing ("how learners understand their activity with respect to knowledge, reasoning, and learning") and the engineering processes reported during the tasks.</p>	<p>Discourse analysis (video recording of PST talk, analysed using Design Activity Coding scheme)</p>	<p>Graduate level pre-service teachers (N=26)</p>	<p>Literature is used as a starting point for learning about engineering; after reading a text, students engage in a related design problem. Models of integration are not cited.</p>	<p>Detailed analysis is reported on the utterance by utterance progress through the collaborative design task. The authors conclude that PSTs epistemological framing was stable, with a clear focus on the engineering design task. Compared to verbal protocol studies on engineers, the PSTs' were less likely to seek information to clarify the design problem with which they were presented; they paid less attention to feasibility. They also paid less attention in defining the overall design problem. Overall, the PSTs' engaged in a 'more limited set of engineering practices' (p.44) than professional or student engineers. The authors conclude that further attention needs to be given to the aspects of the design/engineering process in PSTs' education.</p>	<p>(i) Focus on PSTs rather than practicing teachers, (ii) very small sample</p>	<p>Journal Article (Peer Reviewed)</p>
White (2014) United States	<p>This study examined the effect of having grades 3-8 teachers participate in professional development on integrating literacy practices into science teaching. The study relies on teacher self-report of practices as well as a variety of student measures, including state achievement tests.</p>	<p>Intervention - pre/post no control (researcher-designed instructional practice survey; student reading/science scores in state tests; modified version of the Elementary Reading Attitude Survey; observation and survey at family night event)</p>	<p>Teachers (N=39) (grades 3-8), including special education teachers in one school district</p>	<p>Little attention is given to models of integration in this study. The term 'interdisciplinary' is used without unpacking or reference to broader literature in this area.</p>	<p>Teachers' self-reported use of some practices increased after participation in PD (e.g. differentiation and the teaching of non-fiction text in science); Elementary Reading Attitude Survey data had mixed results, with some items yielding significantly more negative attitudes after the intervention (e.g. on items relating to reading in science class, using a dictionary); other items yielded positive changes (e.g. about learning from science books); student achievement data showed some positive gains (e.g. 81 more students reached proficiency in informational text in the year the project took place; slight gains in proficiency in the Earth and Space Science portion of the state achievement test), however, these results were not uniform or particularly obvious; responses to the family science nights were very positive</p>	<p>(i) Limited information provided on the precise measures/methodology used, (ii) reliance on self-report of practice, (iii) state science scores only available for two grades (5th/8th), (iv) no comparison/control group, (v) state assessment data examined in aggregate only - not individual student improvements</p>	<p>Journal Article (Peer Reviewed)</p>





<p>Wieselmann (2021) United States</p>	<p>This study examined small group interactions among 6th grade students as they completed a series of integrated STEM activities. Students worked in three different small groups (all-girl, all-boy, and mixed-gender) to complete the integrated STEM activities.</p>	<p>Microvideo Ethnography (Observations of three groups: all-girl, all-boy, mixed-gender).</p>	<p>6th Grade students (N=11)</p>	<p>The authors created their STEM activities according to Moore et al.'s (2014) framework for STEM instruction. This includes six key tenets: '(1) a motivating and engaging context, (2) an engineering design challenge, (3) opportunity to learn from failure through redesign, (4) inclusion of mathematics and/or science content, (5) student-centred pedagogies; and (6) an emphasis on teamwork and communication' (p. 1287).</p>	<p>Students' patterns of participation varied both within and across groups as they completed science-focused and engineering-focused activities e.g. girls were highly focussed on worksheets/tangible products to guide their work in science (and found the removal of this tool a source of frustration in the more open-ended engineering activities); boys spent more time off-task but were more likely to use hands-on materials to explore engineering concepts. Mixed-gender groups were more prone to conflict.</p>	<p>(i) group size differed (possible confounder), (ii) Demographic variables etc., may have been a source of variance, (iii) Gender was considered a binary construct, (iv) small sample size</p>	<p>Journal Article (Peer Reviewed)</p>
<p>Wright (2017) United States</p>	<p>This study tested the effects of teaching literacy skills to kindergarteners in the context of science inquiry units (SOLID Start Curriculum), drawing on disciplinary literacy/language.</p>	<p>Quasi-experiment & Design-based implementation research (Teacher measures: survey; online instructional logs (fidelity measure); focus groups and interviews; classroom observations (fidelity measure); Child measures: Peabody Picture Vocabulary Test; Expressive Vocabulary test; SOLID start interview (Researcher designed interview protocol to assess scientific reasoning and vocabulary)</p>	<p>Kindergarten children (N=147)</p>	<p>Language and literacy skills were explicitly embedded in science units, drawing on a disciplinary literacy framing. Vocabulary, reading, writing and oral discussion were embedded in active, inquiry-focused science lessons.</p>	<p>Children in the treatment condition outperformed those in the BAU condition on all four parts of the SOLID Start interview (claim; evidence-based support, receptive vocabulary; use of science vocabulary in context; $p < .001$ for each; Hedges's $g > 0.7$ for each). Multiple linear regression of various predictors indicated that the intervention had the largest effect on post-test scores when science knowledge and oral language were held constant.</p>	<p>(i) Not a full experiment, (ii) limited information on the BAU group, (iii) high levels of scaffolding/support provided to teachers, (iv) intervention took place over a limited time frame, (v) limited amendments made to units at local level</p>	<p>Journal Article (Peer Reviewed)</p>



<p>Yoshida (2016) Japan</p>	<p>The national curriculum in Japan ('Courses of Study') incorporates a period for integrated studies, during which teachers explore topics in a cross-curricular manner drawing on inquiry, problem-based and collaborative approaches. Previous studies have found that teachers find it difficult to plan for this period. This study examines how pre-service teachers were supported to manage the curriculum for integrated studies over the course of curriculum studies module.</p>	<p>No overall design stated (questionnaire of pre-service teachers; performance tasks evaluated using a researcher-designed rubric; peer evaluation questionnaire)</p>	<p>Pre-service teachers (N=69)</p>	<p>This study focuses on a specific integrative feature of the Japanese national curriculum, the 'period for integrated studies'. During this period, teachers deliberately plan cross-curricular learning experiences. The author does not conceptualise a model or understanding of integration beyond stating the requirements of the national curriculum.</p>	<p>Student scores on the task-specific rubric significantly increased from week 1 to week 7 of the module ($t(66) = 5.71, p < .00$). Peer evaluation of tasks indicated that most completed what the authors considered a 'usable and valid' curriculum in the assessment. Questionnaire responses indicated what students considered key features of integrated studies (e.g., importance of setting a theme), challenges (e.g. the amount of time it takes to plan in this way) and benefits (e.g. cooperating with other teachers supports this work).</p>	<p>(i) Focus on PSTs rather than practicing teachers, (ii) researcher designed measures, (iii) researcher evaluating their own students, (iv) lack of detail on what/how PSTs actually planned, (v) no comparison group, (vi) small changes in scores from week 1 to 7 with no clear effect size reported</p>	<p>Conference Proceedings/Papers</p>
<p>Zhang (2012) China</p>	<p>This study examined the effectiveness of the Integrated Experiential Learning Curriculum (IELC) in China. This curriculum was developed to engage Chinese elementary students in science in relation to a range of other disciplines to cultivate a scientifically literate society by focusing science instruction on practical applications of scientific knowledge.</p>	<p>Quasi-experimental design with pre-post data gathered from the treatment and control group (Researcher design measure of (i) teachers' attitude about teaching science, (ii) student attitude about science [Three Dimension Elementary Science Attitude Survey (TDSAS) (Zhang & Campbell, 2010)], (iii) student citizenship beliefs [pre-post data gathered]; Researcher-designed post-measures of (i) student attitude toward the learning environment [What is Happening in this Class (WHIC) (Fraser, 1998)] and (ii) teacher quality classroom observations)</p>	<p>Elementary students (n=385) and their teachers (n=13); Treatment Group: n = 7 teachers; n = 201 students, and Control Group: n = 6 teachers; n = 184 students)</p>	<p>In this study, the authors base their conceptualisations of integration around the Integrated Experiential Learning Curriculum (IELC) that they are investigated. The IELC leverages 'real-world problems' as the comprehensive focus and framework for student learning in the following four areas: science, information technology, social studies, and life skills. Although the four subjects are integrated, science is the foundational focus in this curriculum model.</p>	<p>Both teachers groups improved their attitudes about teaching from pre- to post-measures for the year measured. Descriptive statistics indicated that the teachers in the experimental group showed higher quality performance compared with those in control group in implementing experiential and integrated teaching. After controlling for gender, SES, pre-test scores on attitude towards science, the authors found that IELC treatment positively affected student attitude toward science, despite the influences of the student background information and their previous attitude. Consequently, the authors concluded that the IELC has shown promise for improving teachers' attitudes about teaching science and their teaching quality. The IELC (1) improved students' attitude toward science, (2) their citizen beliefs, and (3) their attitudes about the learning environment. Regarding citizen beliefs however, this improvement was only significant for 3rd grade learners.</p>	<p>(i) short intervention period (1 year)/potential novelty effect, (ii) significant level of PD provided to treatment group (during the summer and regularly throughout the year from the researchers), (iii) groups were not comparable in terms of age/SES, (iv) intact groups, (v) suitability of research measure, (vi) limited range of data gathered i.e. no learning outcome data</p>	<p>Journal Article (Peer Reviewed)</p>

