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Mikko A. Niemelä

Knowledge-Based Curriculum Integration
Potentials and Challenges for Teaching and Curriculum Design

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Abstract
Curriculum integration refers to the integration of educational knowledge or to the building of an interdisciplinary curriculum with the objective of making learning more holistic. Key questions pertaining to curriculum integration include how to differentiate between and integrate knowledge within and across the boundaries of school subjects. However, school subjects often contradict curriculum integration because the subjects seemingly fragment the curriculum. This thesis explores what it means to adopt a knowledge-based approach to curriculum integration and examines the kinds of conditions set by knowledge integration with respect to teaching and curriculum design.

This article-based thesis includes three studies. Two of the studies are theoretical, while the other applies quantitative empirical methods. The studies identify three major conditions affecting curriculum integration. The first study presents curriculum integration as a challenge for teachers precisely because it expands the demands of teacher knowledge. The second study points to the subject-matter-specific character of curriculum integration, meaning that not all subjects can be equally integrated with one another. Given that curriculum integration creates challenges for teachers and is subject-matter specific, the third study suggests that it needs to be addressed more clearly as an issue concerning the organisation of educational knowledge in the written curriculum.

To study the requirements of teacher knowledge and how they change when curriculum is integrated, the thesis applies Lee Shulman's construct of *pedagogical content knowledge*. Then, to examine why knowledge matters at the level of written curriculum, it draws on discussions about *powerful knowledge* in education initiated by Michael F.D. Young and Johan Muller. These two frameworks serve in a mutually complementary way to assess both the level of teaching and that of curriculum design. The knowledge-based approach reveals that integrating educational knowledge is essential to the formation of school subjects and to the design of the curriculum as a coherent whole. The major claim of this thesis is that separate school subjects and curriculum integration are not opposing poles, but rather comprise the basic elements of teaching and curriculum design.

Keywords: curriculum integration, curriculum studies, powerful knowledge, pedagogical content knowledge, general subject didactics

Helsingin yliopisto, Kasvatustieteellinen tiedekunta
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Mikko A. Niemelä

Koulutiedon eheyttäminen
Mahdollisuuksia ja haasteita opetukselle sekä opetussuunnitelman tekemiselle

Tiivistelmä

Koulutyön eheyttämisellä viitataan useimmiten oppiainerajat ylittävään opiskeluun, jonka tarkoituksena on tehdä oppimisesta kokonaisvaltaisempaa. Koulutyön eheyttämisen avainkysymyksiin kuuluu, kuinka koulutietoa voidaan eriyttää ja eheyttää oppiaineiden sisällä ja niiden rajoja ylittäen. Oppiaineet kuitenkin nähdään usein eheyttämisen vastaisena, koska niiden katsotaan pirstaloivan koulutyötä. Tämän tutkimuksen tavoitteena on tulkita koulutyön eheyttämistä koulutiedon kannalta ja selvittää, mitä koulutiedon eheyttäminen edellyttää opetuksen ja opetussuunnitelman tekemisen kannalta.

Tämä artikkeliväitöskirja sisältää johdanto-osan lisäksi kolme osatutkimusta. Kaksi osatutkimusta on luonteeltaan teoreettisia ja yksi soveltaa määrällisiä empiirisiä menetelmiä. Osatutkimukset nostavat esiin kolme merkittävää koulutiedon eheyttämisen ehtoa. Ensimmäinen osatutkimus katsoo eheyttämisen olevan haastavaa opettajille, sillä se kasvattaa opettajan työn vaativuutta. Toinen osatutkimus osoittaa eheyttämisen riippuvan oppiainekohtaisista sisällöistä. Tämä tarkoittaa, ettei kaikkia oppiaineita voi yhtäläisesti eheyttää keskenään. Koska koulutiedon eheyttäminen on opetustyön kannalta haastavaa ja sen lisäksi oppiainekohtaista, kolmas osatutkimus esittää, että eheyttämistä koskevia kysymyksiä tulisi ratkoa selkeämmin opetussuunnitelmaa laadittaessa.

Tutkimuksessa sovelletaan Lee Shulmanin *pedagogisen sisältötietämyksen* käsitettä kuvaamaan, miten opettajan tiedolliset vaatimukset muuttuvat, kun työskennellään eheyttävästi. Lisäksi tämä tutkimus soveltaa Michael F.D. Youngin ja Johan Mullerin kehittämää *voimallisen tietämyksen* käsitettä tarkastellakseen eheän koulutiedon merkitystä koulutyössä. Nämä kaksi teoreettista viitekehystä täydentävät toisiaan, sillä pedagoginen sisältötietämys syventyy opetuksen ja voimallinen tietämys opetussuunnitelman tasolle. Koulutiedon näkökulma paljastaa, että eheyttäminen on tärkeää sisäisesti eheiden oppiaineiden ja kokonaisuudessaan eheän opetussuunnitelman muodostamiseksi. Tämän tutkimuksen keskeinen väite on, että oppiaineet ja opetussuunnitelman eheyttäminen eivät ole toistensa vastakohtia, vaan opetuksen ja opetussuunnitelman tekemisen ydinosia.

Avainsanat: eheyttäminen, opetussuunnitelmatutkimus, voimallinen tietämys, pedagoginen sisältötietämys, yleinen ainedidaktiikka

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I dedicate this work for my mother, cottage industry teacher Anne Niemelä.

Helsinki, May 2022
Mikko A. Niemelä

Study the simplest things. For those whose hour has struck
it can never be too late.
Study the ABC; it is not enough, but study it.
Do not let it get you down but begin to learn everything.
You have to take over the leadership!

Bertolt Brecht 1932 (Trans. Eric Bentley)

List of original publications

I Niemelä, Mikko A. & Tirri, Kirsi (2018). Teachers' Knowledge of Curriculum Integration: A Current Challenge for Finnish Subject Teachers. In Y. Weinberger & Z. Libman (Eds.) *Contemporary Pedagogies in Teacher Education and Development* (pp. 119–132). London: Intech Open. https://doi.org/10.5772/intechopen.75870

II Niemelä, Mikko A. (2022). Subject Matter Specific Curriculum Integration: A Quantitative Study of Finnish Student Teachers' Integrative Content Knowledge. *Journal of Education for Teaching, 48*(2), 228–240. https://doi.org/10.1080/02607476.2021.1989288

III Niemelä, Mikko A. (2021). Crossing Curricular Boundaries for Powerful Knowledge. *The Curriculum Journal, 32*(2), 359–375. https://doi.org/10.1002/curj.77

Contents

1 Introduction

This thesis contributes to ongoing discussions on knowledge integration in the context of schooling. Currently, educators are showing a great deal of interest in integrating the school curriculum, although scholars have already for a number of years maintained that curriculum integration is a topic worth studying. One way to explain the interest on curriculum integration is to describe its significance to education. The process of integrating school curriculum works against the fragmentation of knowledge, which is a consequence of the highly specialised production of knowledge in contemporary society. Therefore, the integration of knowledge and formation of a holistic worldview should be a key *educational* aim of schooling (Carr, 2007). Holistic growth goes hand in hand with studying the specialised disciplinary knowledge produced by preceding generations, which young people can utilise for building their lives and future society. However, the development of a holistic understanding of the world entails integrating knowledge that crosses disciplinary boundaries. In this way, education can advance both harmony or unity, the central guiding principle in the theory of *Bildung* (Kivelä et al., 2012).

The purpose of curriculum integration can also be explained more technically as a question of curriculum coherence[1]. Sullanmaa (2020) considers curriculum integration the single most important factor contributing to curriculum coherence. Curriculum coherence, in turn, is crucial for student learning (Fortus & Krajcik, 2012; Schneider & Stern, 2010). According to Hirst (1969), the more teachers are aware of the logical relations within the curriculum, the more they can promote students' mastery of these relations and the more comprehensive learning can occur.

Broadly speaking, curriculum integration can mean 1) integrating content within school subjects, 2) integrating perspectives from several subjects to study boundary-crossing topics or 3) integrating the school curriculum with the experiences of students, which is not differentiated *per se* along the boundaries of school subjects. This thesis is motivated by the observation that the three approaches are often unnecessarily viewed as mutually exclusive.

The approaches to curriculum integration usually reflect general paradigmatic divides in educational sciences. The influence of the paradigms shifts over time

[1] Sundberg (2022) refers to two types of curriculum coherence. The currently dominant understanding of curriculum coherence is the so-called coordinative approach, which focuses on the systemic perspective. With the coordinative approach, coherence means the alignment between standards, curricula and assessment. Sundberg calls the second meaning of curriculum coherence the integrative approach, which relates primarily to the substantial consistency of a curriculum. Then, coherence depends on curriculum enactment, a process that involves proper epistemic and institutional conditions. In this thesis, curriculum coherence refers mainly to the latter understanding of it.

(see Schiro, 2013). The current discussion on curriculum integration often undervalues the role of knowledge in education, the conditions it creates for schoolwork and the function of school subjects as instruments for the coherent structure of educational knowledge (McPhail, 2019; Young & Muller, 2010). In the longstanding dichotomy between *learner-centred* and *knowledge-centred* educational paradigms (Oelkers, 1994), curriculum integration has been identified too readily with the learner-centred curriculum ideology (Schiro, 2013). This thesis expands current understandings of curriculum integration by reconstructing a **knowledge-based approach to curriculum integration**.

The knowledge-based approach to curriculum integration has not been developed for the first time in this thesis. However, it is important to bring it back into current educational discourse to help avoid an overly narrow understanding of what curriculum integration can mean and of its main purpose. This thesis draws from previous views on knowledge-based curriculum integration and claims that they are still relevant today. An essential objective of this study is to interpret the meaning of knowledge-based curriculum integration in such a way as to stimulate further research on the topic.

The concept of curriculum can be divided into the levels of *intended*, *implemented,* and *attained* curriculum (Thijs & Akker, 2009). The intended level mainly concerns curriculum as a policy written in the form of curriculum documents. Implemented curriculum refers to how teachers perceive of and operationalise the curriculum. Attained curriculum refers to the students' level of learning, to the ways in which they experience schoolwork and to the learning outcomes. The perspective on curriculum integration in this thesis is limited to the levels of designing the **intended curriculum** and teaching it, i.e. to the level of **implemented curriculum**, more precisely to how the curriculum is written, perceived and operationalised. Within the educational sciences, the three levels fall mainly in the fields of curriculum studies and (subject) didactics.[2]

This thesis bridges the levels of intended and implemented curriculum to achieve an overarching perspective that provides tools to answer both the question "What should be learned in schools?" and "How should it be organised for teaching?" Petrina (2004) has claimed that these dialectically interconnected questions have been deeply separated in educational studies since the 1950s. According to Petrina, curriculum theorists have mainly been engaged with the politics of content knowledge but have overlooked the 'realpolitik of form', which deals with concrete questions of instructional design. At the same time, instructional designers have neglected questions regarding curriculum content. By combining the perspectives of the intended curriculum and teaching, this thesis addresses this gap and re-establishes the dialectic of curriculum content and instructional design.

[2] This thesis does not address the perspective of students concerning integrative studying and learning, issues largely researched in the fields of cognitive science, the learning sciences, and educational psychology.

The thesis clarifies the meaning of knowledge-based curriculum integration and explores the kinds of conditions set by knowledge for curriculum integration. This article-based thesis examines knowledge-based curriculum integration via three studies: one published as a book chapter and two as journal articles. Each of the studies examines the potentials and challenges of knowledge-based curriculum integration on a different curricular level.

Study I (Niemelä & Tirri, 2018) focuses on the **level of operationalised curriculum**. It investigates the kinds of knowledge requirements for teachers when integrating curriculum, especially with respect to how they operationalise the curriculum via teaching. Many studies have shown that curriculum integration is a challenging task for teachers (e.g. Grossman et al., 2000; Kneen et al., 2020; McPhail, 2019; Muller, 2006; Palmer, 1995). By applying Lee Shulman's concept of *pedagogical content knowledge*, Study I explains theoretically why curriculum integration is challenging from the standpoint of teacher knowledge. Study I claims that curriculum integration increases the demands placed on teacher to have an in-depth knowledge of the content of various subjects, of the curriculum as a whole and of collaborative teaching arrangements. Shulman's construct has previously been used in the context of subject teaching. The novelty of Study I is in how it applies the framework of pedagogical content knowledge to study the conditions of integrative teaching.

Study II (Niemelä, 2022) concentrates on the **level of the perceived curriculum**. It empirically examines Finnish student teachers' perceptions on integrating topics between school subjects in Finnish lower and upper secondary curricula. Study II shows that student teachers perceive curriculum integration as subject-matter specific, which implies that all subjects cannot be equally integrated. The use of quantitative methods to study curriculum integration has been marginal to date. In addition, previous empirical research that has studied the interrelations between subjects have usually only focused on a few subjects. The use of quantitative methods in Study II facilitates the investigation of student teachers' perceptions of Finnish secondary curricula as a whole, including all subjects.

Finally, because curriculum integration is conceived as challenging for teachers and as subject-matter specific, Study III (Niemelä, 2021a) turns its theoretical attention to the **level of the written curriculum**. A written curriculum can be designed to support integrative teaching via acknowledging the integrative potential of the content of school subjects. Study III reflects on how the written curriculum can be designed to support the overall coherence of the curriculum as well as the teaching-studying-learning process[3] in schools by both maintaining and

[3] Kansanen (2003) describes the teaching-studying-learning process as the relationship between the teacher, the student and the content. Kansanen refers to the relationship between the teacher and the student as a pedagogical relationship. In turn, the didactic relationship refers to a teacher's relationship to the relationship between the student and the

crossing the boundaries of school subjects. Study III engages with ongoing discussions on the role of *powerful knowledge* in education, first initiated by Michael F.D. Young and Johan Muller (2016). Young and Muller (2010) have been critical of recent attempts to integrate school curriculum. The contribution of Study III is twofold. First, it shows that organising educational knowledge is always an issue that concerns both differentiation and integration of knowledge. Second, it demonstrates that curriculum integration can enhance powerful knowledge, that is, coherent discipline-based conceptual knowledge, which allows students to expand their worldviews (Young & Muller, 2016).

This overview is organised as follows. Chapter 2 reviews the history and meaning of curriculum integration. Chapter 3 provides the context for the doctoral research, first by elaborating the term curriculum more in detail and what aspects of it are addressed in the thesis, and then, by introducing the case of the Finnish educational system. Chapter 4 outlines the main theoretical framework of the thesis, the theory of *social realism* and Shulman's construct of *pedagogical content knowledge*, and it explains why they are mutually complementary. Chapter 5 presents the research questions addressed in the thesis and in studies I–III. Chapter 6 describes the theoretical and empirical research methodology applied in the thesis, outlines the function, potentialities and limitations of both methodological approaches and brings them into a mutually beneficial dialogue with one another. Chapter 7 summarises the results of the three studies. Finally, Chapter 8 presents some implications and limitations of the results, highlights potential new directions for research and formulates final conclusions based on the main arguments.

content. With instruction, the teacher can organise the relationship between the student and the content. If successful, it can lead to learning through the act of studying, which is specific to learning in the school context.

2 The history and meaning of curriculum integration

Questions pertaining to curriculum integration have been present since the early days of modern schooling. Nevertheless, discussions on the meaning of both curriculum and its integration are ongoing. According to Pring (1971), in the discussions on curriculum integration, the common denominator has been the critique of some sort of fragmentation of schooling. Especially, fragmentation has been seen as resulting from the unnecessarily strict boundaries between traditional school subjects. Additionally, it has referred to the fragmented learning experience of students. Many have argued that the fragmentation of students' learning experience has resulted from school subjects being studied in small bits and from distancing the subject matter from the life of the students (Beane, 1995).

To advance integration, the German pioneer of educational theory J.F. Herbart (1776–1841) introduced the notion of *concentration* and *correlation* as principles of integration (Tanner & Tanner, 2007). Concentration refers to integrating knowledge through central subjects that connect the content of several subjects. Correlation, in turn, means intentional bridge building between subjects. At the turn of the 20th century, *culture-epoch theory* was popular among follows of Herbart, whereby integration takes place as the child recapitulates the development of civilisation on an epoch-by-epoch basis through the duration of the school years. However, the most cited spokesperson for curriculum integration has been American pragmatist philosopher John Dewey (1859–1952), who continues to be frequently referred to in papers on curriculum integration. Dewey (1900, p. 81) is well-known for his proposal: 'Relate the school to life, and all studies are of necessity correlated.' Thus, Dewey advocated integration via student experience. Both Herbart and Dewey contextualised curriculum integration in their broader educational theories. For them, integration was not just a pedagogical alternative or a practical solution for organising schoolwork appropriately, but a way to answer such philosophical questions as, what is the relation of man to the world? Or how can the democratic functions of society be strengthened through education?

Due to its supposed potential, curriculum integration has been subject to a great deal of interest in recent decades. Critics have pointed to how curriculum integration dissolves the subject boundaries and neglects the role of knowledge in education (Young & Muller, 2010). Much of the current literature on curriculum integration treats it as a practical solution applicable in school settings on a pedagogical level or through school-based curriculum management. As noted above, curriculum integration is commonly presented as a learner-centred alternative to the traditional teacher-centred and subject-based curriculum (McPhail, 2019).

This notion of curriculum integration reflects a broader phenomenon in educational discourse that Biesta (2013) has described as 'learnification'. In short, it means that the role of the teacher, the purpose of education and the questions pertaining to educational knowledge have largely disappeared and have been replaced with a focus on learning future competencies. Correspondingly, Siljander (2017) has noted the disappearance of substance in recent curriculum reforms in Finland. This chapter presents various alternatives to interpreting the meaning of curriculum integration and shows how curriculum integration does not necessarily suggest a disregard for the significance of educational knowledge and school subjects when designing curricula.

2.1 Rationales for curriculum integration

Above, the purpose of curriculum integration was discussed broadly as making learning more holistic and avoiding the fragmentation of knowledge and student experience. Yet, it needs to be specified why and how these objectives should be pursued. Pluim, Nazir and Wallace (2020) identify six reasons for integrating curricula: 1) democratic, 2) environmental, 3) sociocultural, 4) pragmatist, 5) economic and 6) rationalist.

The democratic perspective sees curriculum integration as enhancing democratic education through problem-centred, integrated projects. Students take an active role in designing the projects, which is essential for the development of democratic citizenship. Further, the topics of the projects can be directly related to ethical or political issues. *The environmental perspective* is strongly motivated by the ongoing environmental crisis and aims to encourage students to address the crisis, requiring the integration of various disciplines to better understood current problems and even solve them. The environmental perspective aims at transforming society towards sustainable development. With *the sociocultural perspective*, the importance of real-world phenomena close to the everyday lives of the students is at the centre of the learning process. In the context of complex societies, the sociocultural perspective stresses the need for students' holistic growth by acknowledging the cognitive, physical, emotional and spiritual aspects of learning.

The pragmatic perspective offers curriculum integration as a practical solution to the everyday challenges encountered in schoolwork. Integrating subjects helps resolve timetable and workload management issues. In addition, integration is a tool that can enhance learning outcomes because it allows teachers to better grasp diversities in their classrooms and motivate students to learn. *The economic perspective* also highlights the practical benefits of curriculum integration, but it especially focuses on labour markets and economic change. Just as the pragmatic perspective pays attention to the needs of teachers, the economic perspective focuses on the needs of the economy. The objective of curriculum integration from the economic perspective is to develop students' employability skills. The ability

to successfully integrate skills and knowledge from various fields will be important for future workers, who will need to adapt to the increasingly changing demands of working life, not to mention future entrepreneurs, who may often need to devise boundary-crossing innovations. Finally, *the rationalist perspective* sees the purpose of education as providing each individual with the potential for growth and to make wise decisions on how to live a good life. Integrating the curriculum can promote this aim by ordering complex concepts and thus allowing for deep learning.

In identifying the various perspectives on curriculum integration, Pluim et al. (2020) argue that curriculum integration is not a unitary approach to education, but includes many competing epistemological and ideological views. As mentioned above, what the different perspectives on curriculum integration share is a concern over the fragmentation or disintegration of the existing curriculum. However, they draw a wide range of conclusions regarding how to tackle this curricular deficiency. Therefore, when curriculum integration is discussed, it is important to ask, *what is being integrated*, *how* and *why*. Next, alternative ways to implement curriculum integration are presented.

2.2 Alternative ways to implement curriculum integration

A typical way to present alternative ways of implementing curriculum integration has been to draw a continuum with isolated subjects at one end and the complete abandonment of subject boundaries at the other. The taxonomy suggested by Fogarty and Pete (2009) captures quite well the diversity of alternative views on how to integrate curricula. The taxonomy acknowledges integration within a subject, across subjects and inside the mind of the student. Therefore, this taxonomy creates a comprehensive picture of curriculum integration that is not limited to only integrating different subjects.

Regarding integration within a subject, Fogarty and Pete have identified three alternative kinds of integration. The first is *cellular*: it describes the way in which individual subjects apply a certain disciplinary structure. The second is a *connected* approach, whereby subjects are connected by creating links inside the subjects with topics studied in other subjects. Third, the *nested* approach aims to develop multiple students' skills via studying a certain content area of a subject.

Then, Fogarty and Pete (2009) introduced five ways to integrate curricula across subject boundaries. The first is *sequencing*, which has to do with the arrangement of studying a certain topic first in one subject, then examining it as part of another subject or by studying it simultaneously in relation to two or more subjects. For instance, the ecology of forests can be studied as biology and the economy of forests as social studies. Second, curriculum integration is *shared* when two subjects share content designed to support them both. For example, studying mathematical formulas supports the study of physics. Third, the *webbed* approach

refers to the thematic integration that binds together several subjects around a shared theme or concept. It can be implemented in, for instance, the form of an integrated thematic project on local culture and traditions. Fourth, *threaded* integration means connecting subjects via big ideas, cross-curricular objectives or standards. Future competencies, such as multiliteracy or citizenship skills, serve as examples of cross-curricular objectives. Fifth, Fogarty and Pete defined the *integrated* approach as similar to the shared approach, but it concerns several subjects that bring together unique ways to study a shared topic. This means that, for instance, the content of geography, biology, physics and social studies can be designed to support studying climate change as an integrative topic.

Additionally, Fogarty and Pete (2009) have described two ways in which integration is possible in the mind of an individual student. *Immersed* integration means that a student specialises in a certain area of studies and looks at various disciplines through the lens of that specialisation. Immersed integration presupposes some optionality in the school curriculum. Thus, immersed integration means concentration, not expansion, which is the way in which *networked* integration occurs. Through networking, students learn to collaborate with each other or use multiple sources of knowledge to help generate new ideas and aid the student in understanding a broad topic. Networked integration can take place through, for example, projects or a thesis.

The strength of Fogarty and Pete's (2009) taxonomy is that it does not make claims about the degree of integration when employing any one of the alternatives. Therefore, it is not necessary to see collaboration between school subjects as a stronger degree of integration than integration that takes place within a single subject or by a single student. This is significant when the role of school subjects is considered in curriculum integration. Next, various alternatives for implementing curriculum integration in the Finnish national curricula since the 1970s are examined.

2.3 History and the meaning of integration in the Finnish curricula

In Finnish schools, curriculum integration has been implemented systematically since the beginning of the comprehensive school system, a common period of schooling for all students in the age groups 7 to 16. Before the comprehensive school reform in the 1970s, Finnish school curricula were largely subject-centred and experiments on integration were provisional. The first national core curriculum was introduced at the comprehensive school level in 1970 during a large-scale school reform. It combined the German Lehrplan-type curriculum, which emphasises subject content, and American curriculum thinking, with a focus on integrative objectives (Saari et al., 2017). Ever since, a central debate of Finnish curriculum reforms has been whether the curriculum should be more subject oriented or

integrated. In the last few decades, influenced by broader international trends, Finnish curricula have experienced a shift from a mastery of content knowledge to developing students' competences for the 21st century (Saari et al., 2013; Vitikka, 2009; Vitikka et al., 2016).

Although many papers (e.g. Drake & Reid, 2020; Pluim et al., 2020) have claimed that Finnish schools adopted a radical, integrated curriculum that replaced school subjects with integrative phenomena after the 2014 basic education curriculum reform, school subjects still form the backbone of the Finnish core curriculum for the comprehensive school years (see Finnish National Agency of Education, 2016; Uljens & Rajakaltio, 2017). The integrative aims were stated most strongly in the 1970 curriculum reform. However, it included two divergent parts. The first part consisted of the general aims for schoolwork and included a comprehensive school plan completely based on an integrated curriculum (Komiteanmietintö, 1970a). The latter part included a detailed list of the subject contents (Komiteanmietintö, 1970b). Hence, the two parts of the curriculum reform were somewhat contradictory. The plan for the integrated curriculum was not realised, and questions regarding integration were of lesser importance in the curricula reforms published approximately once a decade ever since (see Niemelä, 2019).

The 1970 curriculum reform describes eight concrete ways to integrate learning across subject boundaries: 1) *parallelise* school subjects in such a way that a theme is studied simultaneously in various subjects; 2) arrange the curriculum in *periods*, during which time only a few subjects are studied; 3) create a *sequence* so a theme can be studied first in one subject or course and then continued in another subject or course; 4) *fuse* different disciplines as broad school subjects, such as social studies or natural sciences; 5) create a curriculum that includes *separate space for broad themes* combining separate subjects; 6*)* incorporate *cross-curricular themes* in some or all subjects; 7) engage in *holistic* learning completely without subjects; 8) and invite spontaneous *integration by an individual student* that can be encouraged by teachers (Komiteanmietintö, 1970a; see Koskenniemi & Hälinen, 1974).

The 1970 national curriculum reform also promoted integration as an objective for the teaching of individual school subjects. Integration can take place within a subject when 1) subject matter is studied in a logical order following the structure of the discipline, 2) the teaching-studying-learning process progresses from the already known to the unknown and 3) the teaching-studying-learning process progresses from the concrete to the abstract and also by 4) interlinking the experiential and cognitive in learning (Komiteanmietintö, 1970a; see Koskenniemi & Hälinen, 1974).

In the most recent curriculum reforms, increasing attention has again been paid to integrative objectives. In 2016, the national core curriculum for basic education

(age groups 7–15) brought back many integrative features from the 1970 curriculum reform and introduced a multidisciplinary learning module as a unit integrating perspectives from multiple subjects with the aim of developing students' transversal competences (Finnish National Agency of Education, 2016). According to the curriculum reform, every student must have the opportunity to participate in a multidisciplinary learning module at least once per school year.

The national core curriculum for basic education defines seven transversal competences, such as learning to learn and multiliteracy, which are embedded in subject content as cross-curricular learning objectives. The interpretation of the integrative objectives of the core curriculum for basic education has been much influenced by the idea of phenomenon-based learning (Lonka, 2018; Tarnanen & Kostiainen, 2020). Some schools have adopted fully the idea of phenomenon-based learning and replaced school subjects with phenomena to be explored. However, it has been more common to interpret the integrative objectives of the curriculum as collaboration between subjects (Venäläinen et al., 2020).

The most recent curriculum reform in Finland has concerned the core curriculum for general upper secondary schools (age groups 16–18), which is structured in such a way that obligatory studies consist of modules that make it possible to integrate the content of two or more subjects. Decisions on which subjects are to be integrated, and to what extent, are made at the local school level. The curriculum also includes cross-curricular objectives shared by all subjects (Finnish National Agency of Education, 2020).

2.4 Previous views on knowledge-based curriculum integration

This thesis builds an understanding of knowledge-based curriculum integration. By presenting a knowledge-based conception of curriculum integration, it contributes to bringing knowledge back to the core of educational discourse. However, the knowledge-based approach to curriculum integration presented here does have historical precursors. Notably, two educational philosophers in Britain, Paul H. Hirst and Richard Pring, presented interesting outlines for knowledge-based curriculum integration in the 1970s. Especially Pring's thinking is in line with the approach adopted in this thesis, and therefore, it is valuable to elaborate on it in detail. To appreciate the contributions of Hirst and Pring, it is important to first place them in the intellectual context of their time, which is essential also from the perspective of the current debate on powerful knowledge in education discussed in Chapter 4.

As in Finland, a shift towards adopting more integrated curricula was taking place in Britain in the 1970s. At the time, researchers actively discussed the role of knowledge in integrated curriculum. A group of academics that became known as the *New Sociology of Education*, with Michael F.D. Young as one of its major

figures, initiated much of the discussion (see Young, 1971b). From the standpoint of the sociology of knowledge, integration represented the dismantling of traditional hierarchies in schooling (Bernstein, 1975). Young (1971a) argued for deconstructing the reified traditional subject structure that he saw as being in the service of reproducing the prevailing power relations in society. Curriculum integration has been promoted using the same arguments also later on (see, e.g. Beane, 1997; Lopes & Macedo, 2009).

In addition to Young, one of the most notable sociologists connected with the New Sociology of Education was Basil Bernstein. Bernstein's (1971) theory on how to classify and frame educational knowledge has been quite influential in the discussions on curriculum integration to this date (Pluim et al., 2020). The dimensions of classification and framing highlight the strength or weakness of the boundaries between school subjects and between school-related knowledge and everyday knowledge. According to Bernstein (1971), the strong classification of school subjects is comparable to possessing private property. Subject groups form the groundwork for building identities for subject teachers and other specialists and protect their specific interests. In turn, framing refers to the strength of differentiating between educational knowledge and the everyday knowledge of students.

Bernstein (1971) saw that by putting less emphasis on framing, groups of students with restricted opportunities to participate in education, such as working-class students, would have better access to the benefits of education. Weak framing means that the value of everyday knowledge is recognised in addition to the value of traditional educational knowledge selected by certain elites. However, Bernstein noted that it is difficult to change how knowledge is classified and framed in educational institutions. The structuring of educational knowledge is an essential element in the 'grammar of schooling', the basic form of which has proven difficult to modify (Tyack & Cuban, 1995).

Advocates of the New Sociology of Education debated their ideas with those of Hirst and Pring, who claimed that disciplinary knowledge has an important function in schooling and that the crucial question is how to structure knowledge to advance the integrative objectives of education. At the same time, a similar discussion was taking place in the US under the heading of 'the structure of the disciplines' (Deng, 2018a; Kliebard, 1965; Schwab, 1978a). Philosophers Hirst and Pring criticised especially the relativist epistemology inherent in the social constructivism adopted by the sociologists of the New Sociology of Education at the time.

As a starting point for his thoughts on curriculum integration, Hirst (1969, 1974) identified seven distinct forms of knowledge: 1) mathematics, 2) physical sciences, 3) human sciences, 4) history, 5) religion, 6) literature and the fine arts, and 7) philosophy. According to him, these seven categories of knowledge are not merely socially constructed categories, although they are manifested only through

social practices. They have some universality and independency of the human mind. Thus, a coherently built curriculum organises its knowledge content by differentiating between these distinct forms of knowledge. But Hirst (1969) also noted that acknowledging the logical interrelations between the various forms of knowledge is necessary to avoid 'ruthless specialisation' and enhance the overall coherence of a curriculum.

For Hirst (1974), the task of curriculum design was to first map the educational objectives and then organise the forms of knowledge to attain them. When using the term *curriculum*, Hirst was referring to some sort of deliberate plan for schooling, as is inherent in, for instance, the Finnish term 'opetussuunnitelma' or the German term 'Lehrplan', which literally translate as 'teaching plan'. Therefore, Hirst saw curriculum integration as a question concerning the organisation of knowledge for schooling. More concretely, Hirst (1974) proposed building on units or subjects that integrate the forms of knowledge. He felt it important that integration has some deliberative purpose and that it avoids breaking the interdependencies of various elements of knowledge. The coherence of the curriculum as a whole or within the various forms of knowledge can suffer if overly distant forms of knowledge are integrated. Thus, the objective of the units or subjects is to recognise both the differences and links between various forms of knowledge.

Pring (1976) agreed with Hirst that well-structured knowledge in the form of school subjects is essential for students to expand their worldview beyond everyday experience and gain access to rational public modes of thinking. However, Pring stated that common sense is the starting point for all rational thinking and for student learning. Therefore, all schooling must begin from the experiences of the students. As mentioned above, this idea was captured also in the Finnish core curriculum reform of 1970. Pring claimed that a specialised teacher who knows the students and the subject being taught quite well can organise the study of a subject in a way that makes it meaningful for the students.

Pring (1976) applied Ryle's (1946) distinction between knowledge-*that* and knowledge-*how* to criticise Hirst for focusing on *what* knowledge should be studied while leaving aside the question of *how* knowledge is constructed. Pring (1976) claimed that in addition to propositional knowledge, it is essential to study how knowledge is produced in various disciplines or can be constructed by the students themselves. On the one hand, Pring blamed Hirst for reductionism, while on the other hand he criticised the New Sociology of Education for relativism. He advocated building a middle-path between the two. Although Pring recognised the role of common sense in schooling, he underlined that the experiences of the students cannot be equated with the public modes of thinking that we call disciplines. Pring thought that the New Sociology of Education school of thought made a mistake by assuming that disciplinary knowledge is exhaustingly determined by the social conditions in which it is produced and, in that sense, not essentially different from common sense.

Pring (1976) noted that the term integration had not received enough attention. In a sense, talk about knowledge-based curriculum integration is tautological because it would be difficult to imagine what knowledge means if it is not integrated as a part of some larger system of knowledge. Therefore, any knowledge-based curriculum is already to some degree integrated. Pring (1971) identified four distinctive approaches to curriculum integration when it is examined from the viewpoint of knowledge. The first one he called the *strong thesis*, which claims the unity of all knowledge. This approach does have problems, though, because although ontologically the world can be conceived as singular, the epistemological questions of how to gain knowledge of it have not yet been resolved. Since the unity of all knowledge cannot be studied at once, the strong thesis poses a significant challenge to designing curriculum that would help make sense of the world.

With the *weak thesis*, Pring (1971) is referring to broad fields of knowledge that can help organise and guide schoolwork. Such broad fields may include, for example, the humanities, science, 'man' or 'time and space'. Pring noted that when a broad fields approach is selected, it needs to respond to how a certain broad field structures knowledge, perhaps in a better way than is possible with traditional subjects. Otherwise, a broad field might be just a selection of arbitrary content under a certain topic, which does not lead to integration. It is also possible to integrate knowledge through a process of *problem-centred enquiry*. However, if the enquiry process is based solely on common sense, it can lead to the fragmentation rather than to the integration of knowledge. Pring saw identifying the *interrelationships between the disciplines* as the most potential way to integrate curriculum, by which he meant discovering concepts or ways of enquiry that can make contributions to two or more subjects.

The knowledge-based approach to curriculum integration has largely remained unexplored during the last few decades. Emerging attempts to deal with curriculum integration from the viewpoint of knowledge include the *curriculum design coherence model*, created by Rata (2019) and McPhail (2020), and *Legitimation-Code Theory*, founded by Maton (2016; Maton & Howard, 2018). Further, Pountney and McPhail (2017, 2019) have developed a model for researching the knowledge base of an integrated curriculum.

Much of the discussion on curriculum integration has presented it as a pedagogical alternative that can be implemented either as a way to integrate the subjects or as a step towards a designing a curriculum that is not divided into separate subjects. Yet, as Hirst and Pring have demonstrated, curriculum integration is not only a pedagogical question; it touches essentially upon the issue of how best to organise curricular knowledge, which has been recently largely ignored in curriculum studies (Deng, 2015). Therefore, Deng (2021) has called for building a new, powerful curriculum theory, one which should include a theory of knowledge and

content that can inform how content for educative teaching is selected and organised. This need is addressed here by offering a view on the meaning, potentialities and challenges of knowledge-based curriculum integration.

3 School curriculum and the Finnish educational system as contexts of the study

Chapter 2 laid out various alternatives for how to understand the idea of integration. This chapter focuses on the meaning of curriculum and thus specifies just *where* integration takes place. Recognising the different levels of a curriculum is essential for understanding knowledge-based curriculum integration. As noted above, curriculum integration is currently understood mainly as a pedagogical arrangement that takes place when the curriculum is implemented (McPhail, 2019). A broader perspective on curriculum reveals that this approach leaves out significant curricular levels and important steps for curriculum integration. Therefore, this chapter broadens the view on the meaning of curriculum.

School curriculum provides the context for this thesis in two senses. At an abstract level, the thesis is not bound to a particular socio-historical curriculum. The meaning of curriculum can be divided into layers, forms or levels that can describe curricula in various contexts. Since Study I and Study II focus on Finland, curriculum in this thesis also refers to the current concrete Finnish context with its specific types of school institutions, teacher education and national curriculum documents. Thus, in this chapter the different levels of curriculum making are first examined in the abstract (section 3.1) and then more concretely in the Finnish context (section 3.2).

3.1 The meanings of curriculum

The everyday meaning of a curriculum usually refers to a collection of content to be taught to students. However, the term curriculum includes a wide array of definitions. A curriculum can have a practical meaning, such as a curriculum document or an activity in schools. From a theoretical standpoint, a school curriculum is an object of study. Although curriculum is originally a Latin term, it has predominantly been used in English-language literature. Some countries have borrowed the term from English, but its meanings vary (Connelly & Xu, 2012; Tanner & Tanner, 2007). Furthermore, for instance scholars in the Continental Europe do not necessarily use the term curriculum at all, but such contexts have their own language-specific terms with different connotations. The meaning of curriculum changes from time to time and from one context to another. In the broad field of curriculum studies, the term has been defined in countless ways. Here, the concept is briefly reviewed and some possible conceptualisations provided.

According to Schiro (2013), the meaning of curriculum is strongly determined by the prevailing curriculum ideology. At its simplest, an ideological division can be made between traditionalists and progressivists (Tanner & Tanner, 2007).

Tomperi (2017) has distinguished between *practice-processual* and *institutional-organisatorial* understandings of curriculum. The first understanding sees curriculum as a process or activity that is constructed socially at various sites. The latter interpretation presents curriculum rather as a product that has an institutional function and manifests itself on different levels. Curriculum integration has mainly been related to the practice-processual meaning of curriculum. As noted above, it has been commonly understood as a pedagogical alternative or school-based form of curriculum management. The knowledge-based approach expands understandings of curriculum integration by presenting curriculum integration also as a way of organising knowledge for institutional settings. This section examines first the practice-processual view on curriculum, and then, focuses on curriculum as a social structure and the curricular levels discussed in studies I–III.

Many scholars consider the institutional-organisatorial understanding of curriculum outdated. Doyle (1992), for instance, has criticised the traditional institutional conception of curriculum because it reduces teachers to mere curriculum delivers and stresses classroom practices as key to a meaningful and efficient education. Doyle has described the role of teachers more as curriculum theorists who can steer the curriculum construction process in classrooms. Doyle's aim was to shift the focus of curriculum theory away from developing an institutional-type curriculum and more towards understanding curriculum, as Pinar et al. (1995) referred to it.

Pinar was a major figure in the reconceptualist movement that began in the US in the 1970s, and he has since strongly influenced the field of curriculum studies. For reconceptualists, who draw much from the postmodernist and poststructuralist traditions, it was important to liberate curriculum from an understanding of it as just an institutional document helping to control the schooling process and the lives of those involved with it. Pinar (1978; Pinar et al., 1995) presented curriculum as a series of interpretations and actions by people engaging with it as a complex conversation with society. The reconceptualist understanding of curriculum treated it more as an abstraction, which is in line with the meaning proposed by Tanner and Tanner (2007, p. 99), who define curriculum as the 'reconstruction of knowledge and experience that enables the learner to grow in exercising intelligent control of subsequent knowledge and experience'.

An understanding of just what is meant by curriculum making takes place at a multitude of sites. Drawing from Thijs and van den Akker (2009), Priestley et al. (2021) have identified five sites of activity for curriculum making: 1) supra, 2) macro, 3) meso, 4) micro and 5) nano. *Supra* sites exist as transnational curricular discourses that include comparisons and policy borrowing. Noteworthy actors at this site of activity include the OECD, the World Bank and the EU. National governments and curriculum agencies form the *macro* site of curriculum activity. These actors are responsible for passing legislation on education and for developing curriculum policy frameworks. The *meso* site is also occupied by governments

and curriculum agencies in addition to, for example, local district authorities, textbook publishers and subject area associations. Their task is to produce curriculum documents, guidance, leadership and support for curriculum enactment. The *micro* site refers to school-level curriculum making, programme design and lesson planning carried out by school administrators and teachers. Finally, the *nano* site of curriculum making takes place in the classroom and in other learning environments where the teaching-studying-learning process takes place. At this site, the actors are the teachers and the students.

Priestley, Philippou, Alvunger and Soini (2021) have criticised the common metaphor of different levels of curriculum making for creating a linear and hierarchical picture that has its starting point in governmental agencies, whose orders are then delivered by the schools and received by the students. Instead, curriculum is actively constructed, interpreted and reconstructed by actors at multiple sites. Schools, including school administrators, teachers and students, not only deliver curriculum that is prepared for them somewhere else, but they then mediate it at their own sites of activity. According to Priestley et al. (2021), the different sites of curriculum making should not be seen as subordinate to each other and without a certain degree of autonomy.

Many curriculum scholars have recently claimed that the postmodern understanding of curriculum has transformed the field of curriculum studies into general cultural studies and distanced it from concrete questions of curriculum making (Connelly & Xu, 2010; Priestley, 2011; Young, 2013). Apple (2018) has remarked that research on curriculum design has consequently lost its influence on society and curriculum reforms. Further, Goodson (2017) points to the loss of historical perspectives in curriculum studies. This has led to a situation where, for instance, the subjects covered in a certain curriculum are taken as a given. To make the meaning of curriculum more realistic, the conception of curriculum as practice must be complemented with the notion of curriculum as an historically formed structure. Although all the previously mentioned sites have a certain degree of autonomy, ignoring the hierarchical characteristics of curriculum making can lead to dismissing the professionalism of teaching, neglecting the socialising function of education and overlooking the crucial distinction between specialised disciplinary knowledge and common sense.

The theory of *Bildung* aims to reconcile these two curricular conceptions by presenting the process of education as a meeting point of the existing culture and autonomy of each young student. In other words, education is a means to reconcile the outer determination of an historically formed culture with the self-determination of each student. Education that includes cultural content is always directed towards some purpose and ends determined by the adult generations (Kivelä et al., 2012). German American philosopher Hannah Arendt saw the function of education as conservation; it should not treat children equally as grownups nor expel

the younger generations from the world of adults, but prepare them for renewing the common world:

> [I]t seems to me that conservatism, in the sense of conservation, is of the essence of the educational activity, whose task is always to cherish and protect something – the child against the world, the world against the child, the new against the old, the old against the new. (Arendt, 1993, p. 192)

Biesta (2017) points to the role of the educational professionals in supporting the democratically formed direction manifested in the curriculum documents. At the same time, educational professionals have the responsibility to apply their expertise to judge the best means for achieving the collectively deliberated objectives and to use their authority to advance them in a practical manner. While educational professionals are bound by, for instance, the existing legislation and administrative decisions, they still have room for autonomous reflection in the instructional process.

Curriculum making includes a variety of professionals who exercise power in other sites at educational institutions. Such power is not an issue *per se* so long as its use is justified through putting it in the service of the general well-being. This idea derives from Kant's solution to the dilemma of forcing children to become free through education. Kant (1900) came to the conclusion that it is the responsibility of adults to ensure the interests of the younger generations, and that only through formation (*Bildung*) that introduces the restraints of life can a child become autonomous. Curriculum making is directed by adults with the aim of steering schoolwork, but as Westbury (2008) claims, the direct influence of a formal curriculum on what occurs in classrooms is at best uncertain. Therefore, Westbury sees the function of curriculum making primarily as ideological steering, because it can only indirectly control the actions that take place within the teaching-studying-learning process.

When curriculum is understood as a plan, as it explicitly is with the German term 'Lehrplan' or the Finnish term 'opetussuunnitelma', it usually means that most of the planning takes place at one site and is enacted at another site. The educational aims and knowledge content form the central components of the curriculum plan (Thijs & Akker, 2009). Aims and content have typically been organised in the form of school subjects. According to Deng and Luke (2008), the selection and organisation of subject matter is one of the most central moments in curriculum making. But they suspect that this process has been understudied because of the highly politicised nature of educational knowledge. Thus, there is a need for a curriculum theory that examines more broadly the place of various subjects in curriculum making and, for instance, how they facilitate or restrict curriculum integration.

According to Westbury (2008), the subjects stabilise the inner work of schooling and form the basis for professional communities of teachers. Subjects make is possible to organise schoolwork, but they also limit the overall structure of a curriculum. Thus, if changes to the curriculum are pursued, for example toward greater integration of knowledge, then the current curriculum and the inner workings of the school implementing it need to be acknowledged. As Young (2021a) states, curriculum development is conditioned by a multitude of path dependencies. The history of schooling has revealed that it has been difficult to achieve sustainable changes in the 'grammar of schooling' when the objectives and actions have stemmed, for example, from political ideologies or economic needs rather than from the needs of education (Tyack & Cuban, 1995).

The process of formation of the knowledge content for a curriculum is usually described as a process of transforming disciplinary knowledge into the form of school subjects. Dewey (1902) has referred to it as the psychologising of disciplines, Schwab (1978b) as translation, Bruner (1960) as conversion, Bernstein (2000) as recontextualisation and Chevallard (2007) as the transposition of knowledge (see Deng, 2007; Gericke et al., 2018; Muller, 2009).[4] It is important to note that in the context of schooling, disciplines not only refer to academic disciplines but also to other forms of knowledge, which Chevallard and Bosch (2014) refer to as 'scholarly' knowledge, such as handicrafts, arts or sports.

Thijs and van den Akker (2009) have designed a taxonomy that distinguishes between different levels and forms of a curriculum (see Table 1). Following the categorisation scheme proposed by Goodlad (1979), they split the representative parts of the curriculum into three levels and six forms. The sites of curriculum activity refer to the places where curriculum making occurs. In turn, the levels and forms discuss curriculum as the product of an activity. The first level is the *intended curriculum*, which can be subdivided into ideal and written curriculum. Ideal curriculum refers to the vision or rationale for a curriculum that is under ideological debate (see Schiro, 2013). In turn, written curriculum refers to the documents that specify the intentions of the curriculum. The second level, *implemented curriculum*, can be split into perceived and operational curriculum. The

Table 1. The primary levels and forms of curriculum discussed in studies I–III (Thijs & Akker, 2009, p. 10)

Levels	Forms	Study I	Study II	Study III
Intended	Ideal			
	Written			x
Implemented	Perceived		x	
	Operational	x		
Attained	Experiential			
	Learned			

[4] Bernstein's concept 'recontextualisation of knowledge' is a term used in discussions on social realism (see Hordern, 2021), which will be focused in the next section.

former refers to how a curriculum is perceived by its users, the majority of whom are teachers. They in turn interpret the intended curriculum. The implemented curriculum becomes operational in the actual teaching-studying-learning process. The third level of the curriculum is constructed by the students in the form of an *attained curriculum*. Its experiential form refers to the experiences of the students in school settings, while learned curriculum refers to students' learning outcomes.

The present thesis focuses on the **intended and implemented curriculum,** especially the transformation of knowledge while making the curriculum at these levels. Section 4.1 addresses the intended curriculum through the theory of social realism, the main concern of which has been the transformation of scholarly knowledge into educational knowledge organised in the form of school subjects. Then, section 4.2 discusses the implemented curriculum from the viewpoint of Shulman's conceptualisation of a teacher's pedagogical content knowledge. At this level, the transformation of knowledge takes place in terms of how the teacher perceives the curriculum and in the implemented teaching-studying-learning process. Section 4.1 discusses the role of knowledge when devising the intended curriculum, while section 4.2 discusses just what its successful implementation requires from teachers.

Study I considers how a teacher's knowledge requirements change when implementing an integrated curriculum. Study II focuses on how student teachers perceive the subject matter in the written curricula of Finnish secondary schools from the viewpoint of curriculum integration. Finally, Study III mainly discusses the importance of maintaining and crossing subject boundaries when designing a written curriculum. Together, these three studies form a comprehensive understanding of what knowledge-based curriculum integration means in practice and some of the conditions impacting it at the operational, perceived and written curriculum levels. The levels are interdependent, as the written curriculum is first perceived by the teachers and then operationalised based on their interpretations of it. The interdependent relationship also functions in the other direction. The written curriculum needs to be designed in such a way that it acknowledges its manageability and pedagogical potential and appropriately supports the teaching-studying-learning process in schools.

3.2 Finnish schools, national curricula and teacher education

In general, children in Finland start schooling at the age of six. Since 2015, one year of pre-school has been compulsory for all. Comprehensive school covers grades 1 to 9, when the students are between the ages of 7 and 15. In 2021, upper secondary education until the age of 18 was also included in compulsory education. Finnish primary school consists of grades 1 to 6 and lower secondary school

grades 7 to 9, which together form the comprehensive school common for all students in Finland. Since the 1970s, Finnish basic education has had only one publicly funded track. After comprehensive school, when students are usually about 15 years old, they choose to continue their studies either in general upper secondary school or in vocational education. General upper secondary school focuses on academic disciplines and is the traditional path to higher education. Vocational education consists of basic and specialised vocational degrees. Except for the matriculation examination at the end of general upper secondary school, the Finnish educational system does not include any standardised testing.

In 2020, 93% of Finnish comprehensive school graduates continued their studies directly in an educational setting leading to a degree: 54% in general upper secondary schools and 39% in vocational education (Tilastokeskus, 2021). Higher education in Finland has two strands, universities offering a bachelor's degree, master's degree and doctoral-level education and universities of applied sciences that offer higher vocational degrees. Both strands are free of charge and open to people with any educational background. In 2020, 20.5% of the age cohort ranging from 35 to 39 had completed a higher education degree at a university and 22.5% at a university of applied sciences (Vipunen, 2022).

The Finnish educational system has received much international attention through its success in the Programme for International Student Assessment (PISA), arranged by the Organisation for Economic Co-operation and Development (OECD). Although the position of Finland in the comparative tests has been slowly declining, it has still been in the top ten in recent assessments (Finnish Ministry of Education and Culture, 2022). The results of the PISA assessments have been discussed widely, although they need to be approached with caution because they are not scientific studies and do not measure how the participating countries are meeting the context-specific objectives of each educational system (Kivinen & Hedman, 2017).

One of the most important factors behind the Finnish results has been the narrow range of variation in the results, which means that the difference between the lowest and highest achieving ninth graders has been relatively low. Further, the differences between schools have been among the lowest together with the other Nordic countries. These results reflect the objective to strengthen social equality through education, which has been the central aim of educational policy in Finland since the 1960s. However, the gap between high achievers and low achievers is slowly growing, and the background of the students has had a stronger correlation with their abilities in recent assessments. It is noteworthy that the difference between genders has been strongest in Finland among all OECD countries, which means that girls have done significantly better in the tests than boys. Some recent attempts to tackle the declining results have included increasing the integrative elements in the national curricula and highlighting the role of students as active constructors of knowledge (Välijärvi & Sulkunen, 2016).

Despite assumptions that Finland's PISA success has had to do with the peculiarities of the Finnish educational system (Simola, 2012), Finnish schools have recently been undergoing reforms at an increasing pace following the internationally shared 'best practices'. These trends include the digitalisation of schooling, a focus on developing generic skills, or the so-called 21st century competences, curriculum integration and reducing teachers' professional autonomy through goal-oriented management. The policy change has been followed by a pedagogical shift from external regulation to self-regulation of learning (Hardy et al., 2020; Siljander, 2017).

The public school system characteristic of the Nordic welfare state model has been challenged of late. When assessed within the framework of the knowledge economy, the role of schooling has increasingly been seen as a key factor contributing to national competitiveness. According to Dovemark et al. (2018), during recent decades the educational systems of the Nordic countries have moved in the direction of deregulation, privatisation and marketisation at the same time as they have witnessed increasing school segregation and social differentiation. However, schools in Finland remain almost completely publicly funded, with profit making and tuition fees banned by law; private schools mainly consist of schools with alternative pedagogies, such as Montessori or Steiner schools, and school choice is limited in basic education.

Finnish national core curricula for basic education and general upper secondary schools define the general and subject-specific objectives of schoolwork, the principles for assessment and the core content of subjects. National legislation and government decrees define the structure of subjects at different grade levels (Valtioneuvoston asetus lukiokoulutuksesta, 2018; Valtioneuvoston asetus perusopetuslaissa tarkoitetun opetuksen valtakunnallisista tavoitteista ja perusopetuksen tuntijaosta, 2018). The core curriculum has the dual role of serving as an administrative steering document and as a pedagogical tool. Designing the core curricula in Finland takes place as a multivocal process involving administrators, unions, education providers, schools, educational professionals, parents and other interest groups (Vitikka et al., 2016), although the design process has recently been criticised for centralism (Säily et al., 2021) and for increased political steering (Uljens & Rajakaltio, 2017).

Local education providers design their own written curricula based on the national core curricula. Overall, many decisions are made at the level of local curriculum making. For instance, local comprehensive schools are responsible for designing the multidisciplinary learning modules mandated by the core curriculum for basic education (Finnish National Agency of Education, 2016). The topics and subjects involved in each module are selected by teachers in collaboration with the students. Each student should have an opportunity to participate at least once a year in such a module.

As mentioned above, curriculum integration has been an objective of Finnish curricula for a considerable period. However, the most recent curriculum reforms have increasingly focused on integration. In addition to multidisciplinary learning modules, the national core curriculum for basic education (age groups 7–15) defines seven transversal competences, such as learning to learn or multiliteracy, which are embedded in subject content as cross-curricular learning objectives (Finnish National Agency of Education, 2016). The new core curriculum for general upper secondary schools (age groups 16–18) is structured in such a way that obligatory studies consist of modules that make it possible to integrate content from two or more subjects. It also includes cross-curricular objectives shared by all subjects (Finnish National Agency of Education, 2020).

Teacher education in Finland is organised into three main strands: 1) primary teacher and 2) subject teacher education programmes, both arranged at universities, and 3) vocational teacher education at universities of applied sciences. Primary teacher education qualifies trainees to teach subjects in primary school grades one to six. Subject teacher education qualifies students to become teachers of one or more subjects in all school levels, including primary school, lower secondary school, general upper secondary school, vocational schools and civic education. Vocational teacher education qualifies them to teach in vocational education in secondary school or higher education. The general requirement to qualify as a teacher in Finland is master's degree or equivalent. Traditionally, teaching as a profession has been a respected career choice in Finland, and the applicant numbers, especially for primary teacher education programmes, have been high (Lavonen, 2018).

The objective of Finnish teacher education is to educate teachers as professionals (Lavonen, 2018). Teaching as a profession is emphasised in a context where teachers have extensive autonomy to make decisions on instructional methods, arrangements and materials. This means that teachers must be able to work in unique situations with a multitude of students, diverse content and different contexts. Teachers are not seen as delivers of schooling strictly controlled outside the classroom, but as actors responsible for considering just what is suitable in specific situations. Therefore, developing teachers' pedagogical thinking is deemed crucial in Finnish teacher education (Kansanen, 2017).

The participants in Study II were student teachers at the University of Helsinki studying to earn a subject teacher's qualification. Each student teacher had studied a certain discipline as a major subject and then entered a subject teacher education programme to earn the formal teacher qualification for the major subject and for possible minors. Some of the participants had entered teacher education after graduating with a master's degree. The Faculty of Educational Sciences is responsible for arranging pedagogical studies for subject teacher education worth 60 ECTS. One third of the studies involve teaching practice at one of the university's teacher education schools, guided by mentor teachers.

4 Knowledge for curriculum and teaching

As mentioned above, this thesis focuses on two levels at which curriculum can be integrated: the intended curriculum and the implemented curriculum. In this chapter, the role of knowledge in schooling is examined first at the level of the intended curriculum through the concept of *powerful knowledge*, recently developed by Young and Muller (Muller & Young, 2019; Young & Muller, 2010, 2013). Ongoing discussions on powerful knowledge help shed light on why knowledge matters in education. To elaborate on the theoretical context of powerful knowledge, this chapter provides an overview of social realism, drawing on its major theoretical predecessors. Then, the concept of powerful knowledge is discussed at the level of curriculum, as discussed in the previous chapter, to specify how powerful knowledge takes its forms at the levels of intended, implemented and attained curriculum through the curricular and pedagogical recontextualisation of knowledge (see Table 5).

Knowledge does not claim its educational powers merely as curriculum policy or documents; it must be actualised through teaching. Therefore, teaching knowledge at the level of implemented curriculum is examined in this section using Lee Shulman's (1986b, 1987, 2015) construct of pedagogical content knowledge. Shulman's framework is useful here because it examines the conditions of knowledge-based teaching in sufficient detail. The construct of pedagogical content knowledge has been used to explain why knowledge matters in teaching. It has been used to evaluate the domains of teacher knowledge essential for subject teaching. This chapter describes why Shulman and his associates saw a special need to address content knowledge in teaching. Then, pedagogical content knowledge is compared with subject didactics, which shares the key idea of content specificity with respect to teaching and learning. As Shulman's construct has held up for more than three decades, its limitations and developments are well acknowledged. Finally, this chapter presents powerful knowledge and pedagogical content knowledge as mutually complementary because a subject-based curriculum is a precondition for powerful knowledge and pedagogical content knowledge describes what kind of knowledge is needed for teaching the various subjects.

4.1 Social realism and powerful knowledge as a curriculum principle

In this section, the role of knowledge at the level of intended curriculum is discussed. This section summarises social realism as the theoretical framework applied in Study III and positions it as part of the current debate on the role of

knowledge in education. The theoretical framework of social realism developed during the last two decades is reviewed with special focus on the work of its key proponent, Michael F.D. Young. As described above, Young was earlier involved in the British New Sociology of Education school of thought, which strongly recommended weakening the boundaries between school subjects and between school knowledge and students' everyday knowledge. However, recently Young (2008) has changed his thinking significantly, joined the school of social realism and called for bringing knowledge back into educational discourse.

The focus on educational knowledge makes social realism a fruitful framework for considering just what a knowledge-based approach to curriculum integration could mean in practice. According to Young (2008), contemporary educational discourse has moved away from the central question of schooling: what should be studied in schools? Instead, the focus has recently been on the so-called 21st-century competences considered crucial for workers in the information age (Miettinen, 2019; see OECD, 2018). Therefore, educational discourse has ended up in a contradictory position. Although the value of knowledge is widely recognised in the current information society, research on education rarely focuses on knowledge itself (Maton, 2014).

Together with his South African colleague Johan Muller, Young has developed the concept of *powerful knowledge* to describe educational knowledge that is based on disciplines, that is organised in the curriculum in the form of school subjects and that provides students with capabilities to think beyond their everyday experiences and to generate alternative visions of the future. In their ideal-typical construction of powerful knowledge, Young and Muller (Muller & Young, 2019; Young & Muller, 2010, 2013) distinguish it from *knowledge of the powerful* and *everyday knowledge*. Although the concept of powerful knowledge has been increasingly applied to other curriculum levels as well, the focus of social realism has been on the level of the intended curriculum, and more specifically on recontextualising knowledge from the perspective of various disciplines to that of the intended curriculum, which is examined mainly from the perspective of sociology of knowledge.

The concept of powerful knowledge has lately gained popularity but has been somewhat distanced from the broader framework of social realism. Powerful knowledge has received interest especially from the proponents of subject education (Gericke et al., 2018; Nordgren, 2021). However, powerful knowledge must be put in the context of social realism to understand how its main concern is with the production and organisation of knowledge for a school curriculum, with the aim of giving all students equal access to the powers of education. Social realism takes a comprehensive approach to school subjects and considers their function as part of the process of recontextualising knowledge for educational purposes.

4.1.1 Theoretical foundations of social realism

Building on the critique offered by Moore and Muller (1999), Young (2008) calls attention to the way in which the New Sociology of Education comprehended the nature of knowledge as 'discourses of voice'. Discourses of voice are characterised by the way they treat experience and knowledge as inseparable. Thus, each social group has its own particular truth, accessible only to those within the group. Taking part in the debate over the social constructivist paradigm in educational sciences, the New Sociology of Education has stressed the socio-historical nature of knowledge (Whitty, 2018). In addition to the New Sociology of Education, Moore and Muller (1999) include some postmodernist, postcolonial and feminist theories based on the social constructivist paradigm as representatives of discourses of voice.

Young (2008) acknowledges that the main achievement of the discourses of voice has been to reveal the power relations that influence the production of knowledge. However, discourses of voice have not been able to point to just what kind of knowledge would be justified in school curricula. For this reason, Young (2013) believes that curriculum studies are in crisis. Nonetheless, Young (2008) still underlines the importance of paying attention to the voices of the discriminated. However, problems arise when it is accepted that each social group has an equally valuable conception of truth, knowledge and facts. This kind of supposition leads to epistemic relativism and the general validity of knowledge is lost. The relativist conception of knowledge has led to the current crisis, in which questions of knowledge in education are overlooked. Social realism claims that the emancipative potential of education stems from objective scientific knowledge that does not merely reflect the truth of a particular group.

Although social realism has developed through a critique of social constructivism, they should not be seen as opposites. Rather, the critique represents a new phase in the development of theory. Social realism would not exist without social constructivism, and the study of the social construction of knowledge remains at the heart of social realism. The foundations of social realism rely particularly on four preceding theories: 1) Émil Durkheim's (1858–1917) sociology of knowledge, 2) Lev Vygotsky's (1896–1934) cultural-historical psychology, 3) Basil Bernstein's (1924–2000) sociolinguistics and 4) the critical realism of Roy Bhaskar (1944–2014). The main objective of social realism is to explain the development of conceptual understanding that enables truthlike knowledge both for individuals and as a social structure.

Young (2008) utilises Durkheim's sociology of knowledge to explain how theoretical knowledge that goes beyond the limits of everyday thinking has become possible in the first place. According to Durkheim, the speculative character of religious thought enabled human thinking to transcend the level of immediate experience. Durkheim called knowledge related to people's everyday contexts secular and knowledge detached from particular contexts sacred. In its developed

form, abstract thinking born as a product of social activity also enables scientific thinking. Durkheimian social science directs its research towards social life seeking social facts, which refers to social structures determining individual activity. Curriculum, educational knowledge and school practices are the types of social facts in which social realism is especially interested.

At the pedagogical level, Young (2008) leans on Vygotsky, who has become a central figure in socio-constructivist learning theory. According to Young, most of the educational research on Vygotsky has lost the distinction between everyday and theoretical knowledge and is thus not able to see the special importance of the school as an institution for learning theoretical knowledge. Young underlines Vygotsky's conception of learning as a world-changing praxis. Vygotsky claimed that the development of conceptual understanding plays a key role in forming a person's experience of reality. In the pedagogical process, students' everyday experiences become connected with theoretical concepts. The conscious relation thus created restructures the everyday experience of students.

Young has been criticised for distinguishing between curriculum and pedagogy (Alderson, 2019; Carlgren, 2020; Gericke et al., 2018). However, Young (2008) sees the distinction as important and compares it to the distinction between structure and agency commonly applied in sociology. Young sees the distinction as essential because it makes it possible to recognise the difference between students' everyday knowledge and specialised educational knowledge structured in the form of a curriculum. Pedagogy brings together students' everyday knowledge and educational knowledge. Referring to Durkheim, Young believes that the abstracted knowledge included in the intended curriculum has its own internal logic. On the other hand, in borrowing from Vygotsky's thinking, Young emphasises the importance of pedagogy in the social construction of knowledge at the levels of the implemented and attained curriculum. Thus, it is essential to distinguish between the different levels of knowledge, first the level of emergent social structure described by Durkheim, and then, the level of social action, which was the focus of Vygotsky, after which scholars must study the relationship between these levels.

The influence of Basil Bernstein has been crucial for social realism. Bernstein took Durkheim's thinking forward by focusing on the structural characteristics of curricular knowledge. Bernstein's analytical concepts have become basic tools of social realism. When analysing the characteristics of educational knowledge, Bernstein (1971, 2000) introduced three major conceptual constructs: 1) classification and framing of educational knowledge, 2) recontextualisation of knowledge 3) and hierarchical and horizontal knowledge structures. Bernstein's conceptualisation of the *classification* and *framing* of educational knowledge was already discussed in Chapter 2. By *recontextualisation* of knowledge, Bernstein (2000) means the process by which expert knowledge becomes selected and restructured first as content knowledge for the intended curriculum and then as

knowledge taught in classrooms (see Table 2). The distinction between *hierarchical* and *horizontal* knowledge structures is applied and elaborated on in Study II.

In the search for the foundations of objective knowledge, Young and Muller (2016) rely on the epistemology of the German philosopher Ernst Cassirer. In turn, Moore (2014) locates the philosophical basis of social realism in the critical realism of Roy Bhaskar, which can be presented as the mainstream epistemology of social realism. According to Moore, critical realism is based on three fundamental views. First, it adopts a realistic ontology. Both natural and social reality exist outside the individual mind. This is also the basis of fallibilism, i.e. the notion that all knowledge is potentially erroneous, because we can never completely correspond our knowledge with the reality that is independent of our experiences. Second, critical realism is based on relativistic epistemology in the sense that all knowledge depends on the conditions in which it is produced. Social constructivism is also relativistic in this sense, but the difference is that social constructivism reduces knowledge to the perspectives of the individual or groups, whereas critical realism emphasises the emergent nature of knowledge. This means that knowledge emerges on a relatively autonomous level from the social processes that produce it, and thus, it cannot be reduced to individual consciousness or to the interests of a particular group. The third view involves trusting in judgmental rationality. Fallibilism is complemented by reliabilism, which means that it is possible to distinguish reliable knowledge from mere belief. It is important to evaluate the criteria for knowledge production both rationally and communally. According to critical realism, at least in the long run it is possible to evaluate the criteria as a community without a commitment to specific interests or identities. Thus, objective truth can be approached. Adopting the term used in the scientific realism, one can speak of *truthlikeness* and its growth (Niiniluoto, 1999).

4.1.2 Powerful knowledge as the objective of future education

Wheelahan (2007) was the first to use the concept of powerful knowledge in the context of social realism. However, Young and Muller (Muller & Young, 2019; Young & Muller, 2010, 2013) have developed the concept considerably further and distinguished it from everyday knowledge and knowledge of the powerful. With the concept of powerful knowledge, Young and Muller aim to overcome the pervasive knowledge-centred and learner-centred dichotomy in education discourse (Oelkers, 1994; Willbergh, 2016), although their perspective has been criticised for being a return to the scientism of the knowledge-centred approach, which advocates rote learning driven by the interests of the powerful (Eaglestone, 2021; White, 2018).

Powerful knowledge relies on the knowledge produced by specialised scientific disciplines. It means a systematic conceptual understanding that allows for

an expansion of students' worldviews. Coherent conceptual systems that are based on disciplinary structures help students to make sense of the world. However, powerful knowledge does not mean only the acquisition of knowledge. It also means studying how knowledge is constructed by the disciplines and in other spheres of society. In this way, it can support the development of a type of critical thinking that helps to question the knowledge of those in power and the given truths that are seemingly a part of everyday common sense.

On the one hand, powerful knowledge differs from *everyday knowledge* by both being more comprehensive and specialised. Everyday knowledge is based on inevitably narrow subjective experience. On the contrary, powerful knowledge is conceptual by its nature. Disciplinary concepts are not exhaustively dependent on their particular contexts. Therefore, conceptual understanding allows students to comprehend wide-ranging phenomena and realise the connections between them (Muller & Young, 2019; Young & Muller, 2010, 2013). Schools offer a special opportunity for learning reliable conceptual knowledge based on the previously described disciplinary praxis.

In contrast to everyday knowledge, powerful knowledge relies on expert knowledge, the production of which requires specialisation. For this reason, Young (2014) notes that schools need to teach subjects that allow students to concentrate on the specialised content of different disciplines and on the ways they produce knowledge. For powerful knowledge, it is important to maintain boundaries between everyday knowledge and expert knowledge as well as between specialised school subjects. Therefore, Young and Muller (2010) have been critical of the idea of curriculum integration[5]. However, their critique is directed at a conception of curriculum integration that aims to dissolve the subject boundaries and stresses the role of students as constructors of knowledge. Thus, the object of critique is not the same as the knowledge-based curriculum integration presented in this thesis or in other studies that apply social realism or the concept of powerful knowledge to curriculum integration (e.g. Maton & Howard, 2018; Nordgren, 2021; Pountney & McPhail, 2019).

Beck (2014) has stated that the division of subjects in curriculum design has been the most challenged idea related to powerful knowledge. Young's approach has been criticised for preserving the traditional structure of school subjects (Priestley & Sinnema, 2014). However, Young and Muller (2010, 2013) note that the act of assigning subject boundaries does not rule out boundary crossings and

[5] Young's view on curriculum integration has changed gradually over the course of his career (Young, 2010). At first, Young (1971a) was a strong proponent of curriculum integration. He considered the boundaries of school subjects to be historical constructs that reflected the repressive power relations in society. Later, with reference to the concept of 'connective specialisation', Young (1998; see Spours, 2018) attempted to overcome overspecialisation via a principle that would enable students to make connections between the various subjects to gain a better sense of the world as a whole. Currently, Young sees curriculum integration as a pedagogical rather than a curricular question.

that subject boundaries can change over time. Wheelahan (2010) has claimed that in the social realist framework, the importance of subject boundaries needs to be recognised, but just where the boundaries should lie and the nature of their permeability should be open for discussion. However, the concept of powerful knowledge has remained vague in this regard. Study III clarifies why curriculum integration can support the development of powerful knowledge through the simultaneous maintenance and crossing of subject boundaries.

Knowledge of the powerful consists of an ideologically selected collection of truths (Muller & Young, 2019; Young & Muller, 2013). Its features are the permanence of knowledge and a lack of systematic evaluation. In line with epistemological realism, Young and Muller do not wish to give up on the pursuit of truthful knowledge. However, the fallibilistic notion of truth separates powerful knowledge from the knowledge of the powerful. Young and Muller claim that all truths should be seen as historical and as potentially rebuttable. They underline the social constructedness of knowledge, though still maintaining the idea that some truths are constructed on better, more reasonable grounds than others. If this assumption is true, it is fair to say that everyone should have equal access to the best possible knowledge.

The key objective of powerful knowledge is to enhance educational equality. Young (2016) states that the purpose of educational knowledge is to provide students with the tools for transcending a worldview built on common sense and influenced by, for instance, those commercial actors most invested in the knowledge of the powerful. This is especially important for students who come to school with low cultural capital, which is common, for instance, for working-class and immigrant students. The aim of the New Sociology of Education was to lower the boundary between school knowledge and everyday knowledge, and thus, to make education accessible for various groups of students. Now, Young finds that it is necessary to maintain this boundary. The important social function of schooling is to build a shared universe for different generations by giving all young people an equal chance to benefit from the best knowledge acquired over time by previous generations.

Muller and Young (2019) suggest that knowledge gains its power on three levels. The first level primarily concerns the specialised academic disciplines, but it also includes the arts. The second level refers to school knowledge, which is formed through selecting and organising the knowledge produced in the various disciplines in a way that makes it suitable for schooling. Hordern (2018) has referred to this level as *powerful educational knowledge*. Educational knowledge is usually organised in the form of a written curriculum. The formation of school subjects that adequately preserve the structures of the disciplines is an integral part of this recontextualisation of knowledge. At the third level, the power of knowledge refers to what students can achieve through knowledge (Muller & Young, 2019).

Table 2. The forms of powerful knowledge on different curricular levels

Levels of curriculum	Forms of powerful knowledge
Intended	Powerful disciplinary knowledge
↕ CURRICULAR RECONTEXTUALISATION ↕	
Implemented	Powerful educational knowledge
↕ PEDAGOGICAL RECONTEXTUALISATION ↕	
Attained	Powerful students' capabilities

Young and Muller have focused on describing how knowledge gains its power at the first two levels, which concern the intended curriculum. Deng (2020) has criticised social realism for the notion that the value of knowledge can be understood intrinsically. In turn, Lambert (2017; Lambert et al., 2015) has refined the notion of powerful knowledge by splitting it into *powerful disciplinary knowledge* and the *capabilities* students can achieve via knowledge. The concept of capability, which Lambert adapts from Amartya Sen and Martha Nussbaum, means, for instance, a person's capability to engage in autonomous thinking, their capability to make choices about how to live and their capability to act as a productive citizen. The capabilities approach differs from competencies as a learning objective because the development of capabilities[6] is tied to the type of knowledge content that enables it.

The various forms that powerful knowledge takes on different curricular levels is summarised in Table 2. On the level of the intended curriculum, the power of powerful knowledge stems primarily from the disciplines themselves: how they construct both scientifically and artistically an abstract and truthful image of the world for students. Acknowledging the educational purpose of disciplinary knowledge makes it possible to recontextualise it in the form of a curriculum. In Table 2, curricular recontextualisation is presented using a two-way arrow because the written curriculum is made as a plan *for* teaching and studying. When the curriculum is implemented, the power of powerful knowledge lies in its educational potential (Deng, 2020; Hordern, 2018; Hordern et al., 2021). Through curricular recontextualisation, knowledge is perceived by the teachers as educational content to be taught. When the content is operationalised as the teaching-

[6] The capabilities approach described by Lambert can be compared with *Bildung* (formation), which has been understood as the objective of education in the Continental European didactics tradition. The idea of *Bildung* will be briefly elaborated upon in the next section. Deng (2020) has proposed that some of the limitations of the concept of powerful knowledge could be overcome by connecting it to the tradition of *Bildung*. In turn, Niemelä (2021b) has proposed that powerful knowledge could help researchers better understand what kind of role knowledge plays in contemporary *Bildung*.

studying-learning process, pedagogical recontextualisation takes place.[7] Through successful pedagogical recontextualisation, students have the possibility to develop powerful capabilities. Next, Shulman's framework for pedagogical content knowledge is used to discuss the role of teacher knowledge in pedagogical recontextualisation at the level of the implemented curriculum.

4.2 Pedagogical content knowledge as the knowledge base for a professional teacher

Young (2008) has stressed the need to bring knowledge back into the discussion mainly as a question concerning the intended curriculum. Two decades earlier, an American scholar, Lee Shulman (1986b), called attention to a 'missing paradigm' in the study of teaching, by which he meant a lack of focus on the knowledge teachers apply when implementing curriculum. Shulman became well known for introducing the concept of teacher's *pedagogical content knowledge* (PCK), which highlights that teaching is always about teaching something, some specific content for specific groups of students. This section presents an overview of Shulman's framework of pedagogical content knowledge. Thereafter, it discusses how these two different frameworks can act together in a complementary way on two different curricular levels.

4.2.1 The conceptualisation of pedagogical content knowledge

The construct of pedagogical content knowledge has received a variety of interpretations since Shulman's original formulation (see Hashweh, 2013). Originally, Shulman (1987) identified seven major categories of teacher knowledge: 1) general pedagogical knowledge, 2) knowledge of learners, 3) knowledge of educational contexts, 4) knowledge of educational ends, purposes and values, 5) content knowledge, 6) curriculum knowledge and 7) pedagogical content knowledge (see Ball et al., 2008). This list of teacher's knowledge categories is by no means exhaustive. The list could be expanded to describe a myriad of knowledge categories (Wilson et al., 1987). These domains of teacher knowledge make sense only in relation to each other, especially with respect to the concept of pedagogical content knowledge, which fuses various types of teacher knowledge (Carlsen, 1999). Since the concept of pedagogical content knowledge is the unifying key category in Shulman's framework, it has been adapted as the title of his theory.

Shulman's key idea was that good teaching is not primarily about managing teachers' behaviour, with a view of teaching only as curriculum delivery, or that teaching praxis could be developed solely by sharing the best practices. Further, a

[7] Bernstein (2000) refers to the space actualised by curricular recontextualisation as the 'official recontextualising field' and to the space actualised by pedagogical recontextualisation as the 'pedagogic recontextualising field'.

teacher's general pedagogical knowledge or knowledge about classroom management alone do not lead to meaningful learning. The concept of pedagogical content knowledge synthesises a teacher's pedagogical knowledge with content knowledge of the subject matter. When teachers possess an adequate mix of pedagogical knowledge and content knowledge, they can pedagogize the content in a learnable form, for instance through suitable examples, analogies or exercises. The practical conclusion of this theoretical idea is that teacher education has an important function in facilitating the development of pedagogical content knowledge. Mere content expertise does not make a good teacher. Neither it is possible for a teacher to achieve a good pedagogical level without any content knowledge. Teachers must know just what it is they are teaching.

A research group led by Shulman at Stanford University empirically tested each of these claims. For instance, Grossman (1990) compared a group of beginning teachers, some of whom had attended a teacher education programme and others of whom had not. Based on her empirical evidence, Grossman concluded that mere classroom experience is not sufficient for pedagogical content knowledge to develop. According to Grossman, teacher education allows for theoretical reflection on teacher practice, a precondition for teacher professionalism, which means that teachers can apply their knowledge versatilely in varying situations. However, just as teaching is content specific, so too should teacher educational programs be subject-matter specific.

Hashweh (2013), another of Shulman's students, emphasised the topic-specific nature of pedagogical content knowledge. Hashweh described the development of pedagogical content knowledge as a process of planning, teaching and reflection. Through this process, a teacher can develop expertise in teaching the most regularly taught topics over time and thereby gain experience. A topic-specific interpretation of pedagogical content knowledge is essential for knowledge-based curriculum integration because the topics are not bound to certain subjects but can instead be organised in various ways, for instance as traditional or integrated subjects. Further, topics can act as integrative bridges between two content areas. Studies I and II develop the idea of integrative content knowledge, which refers to teacher knowledge of fruitful integrative topics. Figure 1, which is presented in the last chapter, describes the integrative teaching-studying-learning process, where content knowledge is constructed through integrative topics. The topic-specific interpretation of pedagogical content knowledge makes it compatible with the idea of curriculum integration.

Shulman (2015) acknowledges that the original theory left out many important categories, but the work of other researchers has advanced general understanding of PCK in many ways. For instance, the category of *technological pedagogical content knowledge* has received much attention in recent decades (Koehler et al., 2013; Mishra & Koehler, 2006). Shulman's construct can be further developed through creating new categories that reveal important aspects of a teacher's

knowledge base. For the purposes of this thesis, Study I develops a new category termed *integrative pedagogical knowledge*, which, it is argued, is useful for studying how curriculum integration takes place. Integrative pedagogical knowledge is a domain of teacher knowledge that points to the knowledge requirements that teachers need for integrative teaching.

When Shulman presented his ideas on PCK in the 1980s, his goals were to strengthen the position of teachers by pointing to the specific knowledge requirements of the profession (Shulman, 2015). Shulman took part in founding the National Board Certification of Teachers to guide teacher education in the United States, and he wanted to raise the status of teaching as a profession. He compared it with being a physician, whose professional thinking Shulman studied before turning his attention to teaching. Shulman (2005) called for teacher education with a specialised *signature pedagogy*, which means educating student teachers to think, perform and act ethically as autonomous professionals who are experts in their fields. He compared the education of professional teachers with the education provided people in other professions, such as medical doctors, lawyers or engineers. Shulman (1986b, 1987) doubted the idea that anyone who has some knowledge of the subject content could be a successful teacher. He stressed the specific cognitive abilities of a professional teacher that take time and experience to develop.

By focusing on teachers' pedagogical thinking, Shulman pointed to the insufficiencies of the then-dominant behaviourist stimulus-response model in research on teaching, which looked at human actions only from the outside. PCK is an attempt to formulate the special area of a teacher's professional knowledge (Carlsen, 1999). Although the field of educational research has changed drastically in the last three decades, we are again in a situation where the role of professional teachers and knowledge in the educational sciences needs to be re-examined (Biesta, 2013, 2017; Willbergh, 2016; Young, 2008). The predominant 'New Science of Education' resembles the behaviorist paradigm in focusing on the development of evidence-based instruments that can increase students' learning outcomes, together with the aim of discovering just what works, findings which can be delivered to the classrooms via teachers (Furlong & Whitty, 2017).

Educational research has been *decontextualised* from the historical and institutional frameworks of education (Saari, 2016; Simola, 1998). From Shulman's perspective, it could be specified as a *decontentualisation* of education, which is undermining the role of the teacher. As noted above, Biesta (2013) has described the ethos of current educational discourse as 'learnification'. Again, the role of teachers is being questioned, as teachers are increasingly seen as facilitators of learning rather than as professionals with expert authority based on their knowledge and ability to make context- and content-specific pedagogical judgements (Biesta, 2017). Therefore, Shulman's thinking that a teacher's knowledge constitutes the foundation of teaching is topical today. Moreover, as Shulman

(1986a) noted three decades ago, it is important to understand that the methods or procedures applied as part of the so-called positivist or scientistic paradigm should not be ignored but that the approach has been too limited in its scope. For instance, the behaviorist models were able to explain some but only limited aspects of human behaviour. Thus, it is significant to avoid reducing positivism or the New Science of Education to a general strawman in educational discussions (see Töttö, 2000).

4.2.2 Pedagogical content knowledge and subject didactics

According to Kansanen (2009), PCK shares the basic idea with Continental European subject didactics: teaching is about teaching specific content to specific groups of students. Hudson (2022) understands pedagogical content knowledge as knowledge that is required to guide the didactic relationship between the student and the educational content (see Figure 1). However, although the dialogue has increased since the 1990s, Continental European didactics and the American curriculum tradition have developed quite independently side by side for a considerable time (Hopmann, 2015). In North America, Shulman's liberal arts-influenced thinking has acted as an alternative to a mainstream American curriculum tradition that generally has not recognised the role of teachers as autonomous professionals (Westbury, 2000).

The subject didactics tradition has been considered broader in its scope than pedagogical content knowledge (Gericke et al., 2018; Rothgangel & Vollmer, 2020). According to Kansanen (2011), PCK can be seen as more specific than subject didactics in the way in which it differentiates certain areas of knowledge for teaching, thus making it more useful for empirical research. In turn, the subject didactic tradition emphasises more the general purpose of education, which is referred to as *Bildung*. In the subject didactics tradition, students' learning of subject-related knowledge and skills lays the ground for *Bildung*. Schneuwly and Vollmer (2018) define *Bildung* as the 'cognitive development, emotional stability, and ethical maturity [of students] which allows them to become autonomous and independent in the long run and self-responsible as individuals and social beings'. Subjects have their domain-specific objectives for learning, but *Bildung* provides a common purpose for all education. Since PCK is a concept used to study the knowledge requirements of teaching, Shulman has not invoked it when discussing the purpose of education at length, which is one of its limitations.

4.2.3 Limitations of Shulman's original construct

Shulman's thinking has faced various types of critiques. Stevens et al. (2005) have pointed out that Shulman's focus on teaching has left aside the question of how students actually construct their understanding of school subjects. Further, Friesen

(2021) has remarked that PCK has neglected the subjectivity of the student. However, such criticisms have often detached the concept from Shulman's broader agenda, and many studies applying PCK have merely instrumentalised it (Carlsen, 1999; Hashweh, 2013). Therefore, criticising Shulman for neglecting students' subjectivity does not entirely hit the mark. Shulman's (1987) model of pedagogical reasoning and action is very much aligned with, for instance, Klafki's (2007) didactic analysis in the way in which it combines theoretical reflections on educational content with the ultimate aim of supporting the development of students through teaching arrangements. According to Shulman (1986a, p. 17), '[t]he consequences of teaching can only be understood as a function of what that teaching stimulates the learner to do with material'. Thus, although Shulman's research has a focus on teaching, it does not ignore the cognitive and the experience of the student.

Shulman (2015) acknowledges especially four shortcomings in his original conceptualisation of PCK. First, it did not pay enough attention to the non-cognitive and moral side of teaching. To a large extent, the everyday work of teaching is about dealing with emotions and guiding motivation. Thus, second, Shulman sees the original formulation of PCK as overly intellectual, overlooking pedagogy as action. According to Shulman, behaviourist theories, with the concept of PCK having originally served as a critique of some of the shortcomings such theories, were nonetheless correct in focusing on what the teachers actually do. Having participated in the cognitive revolution in psychology, Shulman had been sceptical of how behaviourist research typically measured learning outcomes. Yet, he overcorrected and the lack of attention paid to learning outcomes was the third drawback in how PCK was originally formulated. Shulman reminds us that outcomes are not measured only for the purpose of accountability; teachers have a moral obligation to take them into account when considering the needs of students. Fourth, PCK did not take seriously enough the social and cultural context of education. As Shulman (2015, p. 10) states:

> I now understand that the big idea within PCK was that all teaching must be mindfully situated in the disciplinary, cultural, personal, and social settings in which it occurs. PCK is about the importance of situating teaching in all those 'cultures' in the sense of 'culture' that we use in science, as a medium within which things grow (or die).

Further, as Deng (2007) has claimed, Shulman did not adequately consider just what content should be taught and why, causing him to dismiss the recontextualisation of disciplinary knowledge as subject matter. According to Deng, this recontextualisation process is essentially a task of curriculum design and not merely a pedagogical question, as assumed by Shulman. Thus, it is vital to distinguish between curricular and pedagogical recontextualisation (see Table 2). From the

perspective of curriculum integration, this neglect leaves open the crucial question of how subject matter should be appropriately integrated for teaching purposes. However, it needs to be noted that Shulman developed the PCK concept in the US during the 1980s, when state-wide written curricula did not really exist (Deng, 2018b). This made the analysis of curricular recontextualisation less relevant for him. The analysis of powerful knowledge as a curriculum principle can compensate quite well for this shortcoming.

Many other limitations of PCK have also been pointed out during the past few decades. One could even ask whether PCK is already outdated. On the contrary, it is precisely because of such criticisms that Shulman's original ideas have been refined and assumed better explanatory power in the last three decades – ideas that have found correspondence in the tradition of subject didactics, whose roots date back much earlier than the 1980s. Although researchers of PCK have recognised many shortcomings, they have not seen a need to give up on the concept and Shulman's core assumptions; rather, they have devised new categories for the concept, have exposed it to empirical testing and have built a more comprehensive and complex framework around it (Gess-Newsome, 2015). PCK should be seen as a conceptual tool to study specifically the knowledge base for teaching. It needs other theories to reveal how knowledge for teaching is constructing socially and historically, not as something existing in the minds of teachers or taken as a given (Carlsen, 1999). This thesis contributes to both the criticism and refinement of PCK from the perspective of curriculum integration. Here, PCK is complemented by the concept of powerful knowledge, which serves as a tool to analyse the social construction of educational knowledge. Next, the complementarity of these two frameworks is discussed further.

4.3 Powerful knowledge and pedagogical content knowledge as complementary frameworks

Both Young and Shulman have underlined the question of what should be taught and studied in schools. Friesen (2021) mentions these two thinkers as notable exceptions in the general avoidance of the topic of educational content in contemporary educational research. Social realism and PCK are mutually complementary because they point to the same issue, but they have operated mainly on different curricular levels. Social realism has focused on the general importance of knowledge in education and the role of school subjects in intended curricula. Young considers school subjects that draw from the knowledge of the scholarly disciplines pathways to powerful knowledge and is particularly interested in how disciplinary knowledge is recontextualised as knowledge for schooling. In turn, Shulman has not concentrated to the same degree on questions concerning the intended curriculum, but he has taken school subjects as the starting point for studying just how a curriculum is implemented through subject teaching. The

powers of powerful knowledge do not exist in curriculum texts but depend on how a particular curriculum is implemented as a successful teaching-studying-learning process in schools. Thus, after curriculum and pedagogy have been separated for analytical reasons, they must be brought back together to examine how powerful knowledge can be teachable. In addition to the curricular recontextualisation of knowledge, the pedagogical recontextualisation of knowledge needs equal attention. PCK assumes precisely that role.

The discussions on powerful knowledge have recently attempted to clarify just what it might mean for teachers in instructional practice (Carlgren, 2020; Gericke et al., 2018; Morgan & Lambert, 2018). Alderson (2019) has dismissed powerful knowledge as a vague concept that overlooks the concrete reality of schooling. With the aim of providing a perspective on teaching to powerful knowledge, it has recently been coupled with subject didactics (see Gericke et al., 2018, 2022), although interpretative differences have caused some ruptures in the attempted synthesis that draw from different traditions in educational research (Muller, 2022). As noted above, Kansanen (2009, 2011) has viewed subject didactics as being much in line with Shulman's PCK, although PCK as more limited in its scope. According to both the theory of subject didactics (Kansanen & Meri, 1999; Rothgangel & Vollmer, 2020) and Shulman's (1986b, 1987) own formulations, the question of how to teach is deeply connected to the question of what is being taught. Nordgren (2021) has stated that the concept of powerful knowledge has recently hit a nerve in subject education because both focus on the role of content knowledge in schooling. Further, all three theoretical frameworks treat teaching as a profession that requires extensive education to enable teachers to act as autonomous specialists and responsible decision makers with high epistemic standards (Barrett & Hordern, 2021; Hopmann, 2007; Shulman, 1986b, 2005; Vollmer, 2021; Young, 2021b).

The concept of powerful knowledge has given new impetus to comparative research on the Anglo-American curriculum and Continental European didactics traditions that began in the 1990s (see Hopmann, 2015; Westbury, 2000). Deng (2020) argues that because social realism treats knowledge as valuable in itself, it should be complemented with the *Bildung*-influenced tradition of didactics that has examined the socio-ethical purpose of schooling. Deng sees powerful knowledge as meaningful only when it serves students' self-formation and growth as human beings. In turn, Lilliedahl (2015) sees social realism as a possible bridge-builder between the Anglo-American curriculum and Continental European didactics traditions. Lilliedahl argues that both traditions deal with issues related to the selection and organisation of educational knowledge, but at different levels. Since the curriculum tradition operates especially at the level of the intended curriculum, and since with didactics the implementing of curriculum is the priority, these traditions can complement each other, although this difference in the foci of the traditions has also acted as a dividing factor (Muller, 2022). Young

(2021a) is sceptical of the attempts to reconcile social realism with didactics because he sees the former as based on empirical social science and the latter on idealistic philosophy. Though, as noted above, the tradition of didactics does include several different research strands (Kansanen, 1990).

PCK has not been widely applied in the discussions on powerful knowledge. Since PCK does not carry the many-sided philosophical idea of *Bildung* with it (see Horlacher, 2012), is more empirical by nature and represents the Anglo-American educational thinking, it fits more easily with social realism. Deng (2018b) has attempted to enhance the concept of powerful knowledge by aligning it more closely with that of PCK. For Deng, the crucial question has to do with how teachers can understand the teaching content in such a way that it can be taught to foster the growth of powerful human capabilities. However, according to Deng, a theory of educational content that could guide curriculum making towards the development of these capabilities still needs to be developed. This thesis contributes to building a theory of educational content through examining the integration of educational knowledge in teaching and curriculum design.

The next chapter presents the specified research questions for this thesis, followed by an examination of the methodology used to answer the questions, before studies I–III are summarised as a means of elaborating in more detail on how the research questions have been addressed in the thesis.

5 Research aims and questions

This thesis develops an understanding of knowledge-based curriculum integration. This understanding is furthered via an exploration of the potentialities and challenges of integrating knowledge in teaching and curriculum design. In other words, the thesis identifies the conditions set by knowledge with respect to curriculum integration. These conditions include the nature of knowledge, the functions of human cognition, teachers' and students' capabilities, and the social conditions impacting curriculum making at different levels. The thesis focuses on the conditions at two interrelated levels: 1) knowledge for teaching and 2) organising knowledge in a written curriculum. Since teacher education builds an essential foundation for teacher knowledge, it is examined in studies I and II from the perspective of curriculum integration. The overarching research question can be formulated as follows:

- What is the meaning of knowledge-based curriculum integration, and what does its implementation entail for teaching and curriculum design?

The main research question is answered via studies I–III, which address more specific research questions:

1. What kind of knowledge does curriculum integration require of teachers, and how could that knowledge be developed through teacher education?
2. To what extent do student teachers perceive the integration of school subjects as subject-matter specific?
3. How can both the maintenance and the crossing of subject boundaries enhance knowledge-based curriculum integration?

Studies I–III are summarised in Chapter 7. In the next chapter, the methodological foundations of the studies are described. Since two of the studies are theoretical and one uses quantitative empirical methods, the next chapter provides an overview of both methodological traditions, indicates their value for educational sciences and puts them in dialogue with one another.

6 On theoretical and empirical research in educational sciences

In the field of educational sciences, like in many other human science fields, research methodology is usually divided into qualitative and quantitative methods. Quantitative and qualitative methods can also be combined, and it has become increasingly common to adopt a mixed methods approach. In addition to empirical research methods, theoretical research needs to be included in the methodology of educational sciences, although it can be seen as a method in a slightly different sense. This thesis applies both theoretical and empirical research methods to study knowledge-based curriculum integration. Studies I and III are theoretical studies, whereas Study II is an empirical study that employs quantitative methods. This chapter addresses how these different methodological approaches can complement each other. The strengths, limitations and need to put the different methodological traditions into dialogue with one another are discussed below.

According to Shulman (2004), before its current use the term *method* referred to a way of structuring a scientific argument so that it could be understood by other researchers. This presupposes that the research in question is in some way systematic and disciplinary, i.e. that it follows certain principles. In this way, the research can achieve clarity, be linked to other research and its truthfulness assessed. A method holds a scientific community together by enabling mutual communication. Methodology can be broadly understood as a range of different methods, i.e. as a systematic means of communication by which a researcher describes, understands, interprets, demonstrates or argues a key point with respect to his or her research.

Each scientific discipline has its own research methodology, which characterises the rules of communication in the field. However, the disciplinary nature of educational sciences has received much discussion of late. Biesta (2011; cf. Kansanen, 1995) divides the educational sciences into Anglo-American and Continental European traditions. In the Anglo-American tradition, the field of educational sciences is not treated as an independent discipline, but rather as an interdisciplinary or multidisciplinary field of research focusing on schooling and education. The most significant parent disciplines have traditionally been philosophy, psychology, sociology and history, which have been referred to as the foundational disciplines of educational studies (McCulloch, 2002). In turn, Biesta (2011) sees the Continental European understanding of educational sciences as an independent discipline with its roots in the German *Bildung* pedagogical tradition (Geisteswissenschafliche Pedägogik). According to Biesta, the independence of the Continental European educational sciences is not so much based on the research object – what it studies – as on the research interest: defining the principles

of good education. In Finland, the field of educational sciences has always been influenced by both the Anglo-American and the Continental European traditions (Saari et al., 2017).

Although the field of educational sciences has achieved the status of a discipline in Continental Europe, a significant paradigmatic divide has prevailed between didactics and educational psychology (Kansanen, 2002; Rothgangel & Vollmer, 2020). Methodologically, the reason for the dispute is that educational psychology has applied almost solely quantitative methods to the study of learning, while didactics has relied more on qualitative and theoretical research (Rothgangel & Vollmer, 2020).

According to Shulman (2004), the basic quantitative methods of psychological research, i.e. experimental and correlative methods, have proved to be particularly useful in educational contexts. The strength of quantitative methods is that they can lead to general conclusions, which is difficult with qualitative case studies. Quantitative research can be effective in obtaining a large set of data and in statistically assessing the reliability of conclusions drawn based on the data. By calculating the statistical significance of a study, a sample can be used to make statements about a wider population. Qualitative methods, on the other hand, provide details about events through analysis that requires emphatic interpretation by the researcher. The quest to understand the human lifeworld and human experience, which includes uniqueness, has been seen as the crucial task of the human sciences (Juntunen & Mehtonen, 1982). Further, using a mixed methods approach can be fruitful in, for example, an intervention study that quantifies initial and final measurements and uses qualitative methods to ascertain what the measurements have revealed and what factors and mechanisms may explain any changes observed.

Pring (2000) points to the false dualism of qualitative and quantitative methods that has prevailed in much educational research. He suggests that qualitative research can clarify a topic for the quantitative collection of data, and quantitative research, for its part, can reveal topics to be investigated in detail qualitatively. In addition to reducing the antagonism between quantitative and qualitative research methods, Shulman (2004) claims that theoretical research should also be identified as a significant tradition in educational research that form a foundation for high-quality research.

Next, the two research methodologies applied in this thesis, theoretical and quantitative empirical research, are described in more detail. These two different methodological approaches were selected because theoretical research is particularly fruitful in defining conceptual constructs; with respect to this thesis, the approaches clarify the meaning of knowledge-based curriculum integration and its relation to concepts of pedagogical content knowledge and powerful knowledge. In turn, the quantitative empirical method was chosen because it has been marginal in studies on curriculum integration. Study II quantitatively demonstrates how research on curriculum integration can benefit from the powers of statistical

analysis and reasoning and makes it possible to study aspects that would not be possible with other types of methods.

6.1 Theoretical research methodology

In general, the theoretical methodology builds a broad, abstract understanding of a topic, which is not possible with a single empirical study. A theoretical study can draw from empirical research, apply its results and formulate overarching conclusions. Theoretical research is needed to enhance the coherence of knowledge in a scholarly field. Since theoretical research leads to conclusions based on the results of empirical studies, provides critiques of existing research, generates new research questions and clarifies complex scientific discussions, it serves scientific progress and makes it possible to better assess the truthfulness of knowledge (Shulman, 1986a). According to Malmberg (2014), theoretical research is speculative in a positive sense because it, for instance, generates new ideas, explanations and models. But, as Malmberg claims, theoretical research in the human sciences has increasingly been seen as speculative in a pejorative sense, as slipping into metaphysics. It has become a challenge to defend the value of theoretical research in the age of the *New Science of Education*, which demands strict accountability when using such methods as randomised controlled trials, design-based experiments, systematic literature reviews and advanced statistical methods as exclusive pathways to rigorous science (Furlong & Whitty, 2017).

Since the value of theoretical educational research needs to be better understood, this section focuses on elaborating its function. Theoretical research must be distinguished from the theoretical frameworks guiding empirical research. Although theoretical research is common in the human sciences, such as sociology, philosophy and educational sciences, the handbooks on research methodology rarely include a section on theoretical research. In the next section, the empirical methods applied in Study II are described on a step-by-step basis. While the procedures guiding the theoretical research are not described in such detail, the general research strategies used in Studies I and III can be presented as follows.

Both Study I and Study III theoretically examine the concept of curriculum integration. They apply different theories as tools or lenses through which to investigate the knowledge conditions of curriculum integration. Study I takes Shulman's construct of pedagogical content knowledge as the starting point and then asks whether certain teacher knowledge domains change if they are put in integrated contexts. Study I examines theoretically what Shulman's construct can reveal when it is transferred from its original subject teaching context to an integrative teaching context. This is a theoretically sound move because pedagogical content knowledge concerns content specific teaching, which does not necessarily just mean content within traditional school subjects. As noted above, Shulman left the question of how to define school subjects as relatively open.

The discussion on powerful knowledge, addressed in Study III, has also mostly focused on educational knowledge as consisting of traditional school subjects. Study III clarifies the relationship between the concepts of powerful knowledge and curriculum integration. Using theoretical analysis, Study III shows how this relationship depends on the way in which the concept of curriculum integration is interpreted. Then, Study III provides examples of how to organise an integrative curriculum that do not contradict the idea of powerful knowledge. The main theoretical aim of Study III was to present a justified interpretation of the concepts of curriculum integration and powerful knowledge, thus demonstrating why Young and Muller's (2010) critique of curriculum integration does not apply to knowledge-based curriculum integration.

This thesis applies both theoretical and empirical research methodologies that are deeply intertwined. Empirical research is inevitably theoretical because the observations, their direction and the production and interpretation of data are always more or less theory-laden (Brewer & Lambert, 2001). On the other hand, drawing from Klaus Holzkamp, Engeström (2015) has referred to theoretical research as empirical research in the sense that empirical research is *actual-empirical* research and theoretical research *historical-empirical* research. The historical-empirical data consist of results from previous empirical studies as well as theory-historical data, referring to the existing theories in the field. According to Engeström, theoretical research progresses through the stages of categorising data and devising concepts for the categories. The central theoretical category for this thesis is knowledge-based curriculum integration, and the data for generating this category consist of historical-empirical findings particularly on the concepts of pedagogical content knowledge and powerful knowledge as well as actual-empirical data presented in Study II.

The methodology employed in the thesis is eclectic. Eclecticism is another term that has gained a pejorative meaning as research that randomly combines various approaches, some more scientific than others. However, Shulman (1986a, 2004) has called for eclecticism in educational sciences, but he stresses the need for *disciplined* eclecticism. If sufficient explanations are provided justifying why certain research strands have been combined for research purposes, then disciplined inquiry can allow for the objectivity of research. According to Shulman, eclecticism is needed to overcome the insufficiencies of a certain research programme with the help of another programme that is also insufficient in and of itself. In this thesis, the two programmes that are in themselves insufficient and combined to support each other are Young's notion of powerful knowledge, which deals with the role of knowledge mainly on the level of the intended curriculum, and Shulman's notion of pedagogical content knowledge, which focuses on teacher knowledge on the level of the implemented curriculum. These programmes and the reasons for combining them were discussed in Chapter 4.

Lakomski (1992) has pointed to the lack of theoretical maturity in educational sciences, which has kept the field fragmented along its contributing disciplines. The growth of knowledge in educational sciences has been limited because the research paradigms stemming from the contributing disciplines have been incommensurable and research has mainly been devoted to development projects focusing on practice (Connelly & Xu, 2010; Pring, 2000; Salminen & Säntti, 2017; Siljander, 2011). According to Carr (1998), the rise of postmodernism following the period after the Second World War resulted in a strong focus on pluralism in educational theory, which has made it difficult to have a shared discussion in the field. However, Muller and Hoadley (2021) point out that the theoretical orientation of the Continental European didactics tradition has been able to maintain its coherence in comparison to Anglo-American educational studies. Still, the didactics tradition has also included many competing paradigms (see Kansanen, 1990).

According to Kansanen (1995, 2002), the didactics tradition has aimed to construct a comprehensive metatheory that could grasp the entirety of the teaching-studying-learning process in the institutional context of schooling. As the research in the didactics tradition has emphasised philosophical analysis (Kansanen, 2020), studies have to an extent examined the practices and realities of everyday schooling as secondary to conceptual analysis (Hordern et al., 2021; Säntti et al., 2018). For this reason, the position of didactics has been declining in recent decades and more empirically oriented research has gained space (Vollmer, 2021). Nevertheless, Deng (2021) has suggested that the didactics tradition can act as a good example of an attempt to build a comprehensive theory that takes the inner workings of schooling as a starting point, applies theories in a critical, creative and eclectic manner, and aims at concretely developing school practices. It is evident that this direction would presuppose a well-developed dialogue between empirical and theoretical research.

6.2 Empirical research material and methods

Study II was conducted in the form of quantitative empirical research. The method was chosen to allow for a comprehensive comparison of the integrative potential of all subjects included in the Finnish national secondary curricula. A questionnaire was created to study student teachers' integrative content knowledge, with 243 student teachers studying at the University of Helsinki to qualify as subject teachers answering the questionnaire. Then, the answers were analysed using multiple statistical methods. The data collection process occurred in connection with general lectures on curriculum integration in February 2019 and February 2020. It took place after the lectures to ensure that all the respondents had at least a preliminary understanding of the meaning of curriculum integration. Student teachers' primary teaching subjects are listed in Table 3, while their secondary

teaching subjects are listed in Table 4; other general characteristics of the participants are presented in Table 5.

The questionnaire was designed for the purpose of the study using Qualtrics software. The participants were able to use their mobile phones to answer the questions. A small number of participants chose to respond to the questionnaire in written format. The aim of the questionnaire was to investigate whether there are differences among student teachers regarding how they perceive the subjects' potential for integration. Further, if any differences were discovered, their correlations with the background variables were then investigated. In addition to questions on background variables, the questionnaire also included 22 subject-specific questions asking the participant to evaluate how easy or difficult it is to generate topics linking one's primary teaching subject with other subjects.

The primary teaching subject is typically the student's major subject at the university. The evaluation of the relative ease or difficulty in generating integrative topics can be presented in a more convenient way as student teachers' readiness to develop integrative topics linking subjects. Therefore, Study II refers to students' major subjects and to their readiness to develop integrative topics. Thus, Study II investigates how the student teachers reportedly perceive the curriculum, not the subject matter itself. Further, Study II does not reveal the integrative content knowledge of the respondents, but rather how they perceive their knowledge potential. The subject-specific questions were presented using a four-point Likert scale (1 = 'very difficult to generate', 2 = 'difficult…', 3 = 'easy…', 4 = 'very

Table 3. Primary subjects to be taught by student teachers

Major subject	*N*
Mathematics	42
Other foreign languages	35
Mother tongue and literature	34
Religion	34
English	27
History	13
Biology	12
Chemistry	12
Physics	11
Swedish	10
Geography	7
Psychology	2
Philosophy	2
Social studies	1
Visual arts	1
Total	243

Table 4. Secondary subjects to be taught by student teachers

Major subject	*n*
Mathematics	20
Other foreign languages	19
Social studies	17
Ethics	16
Swedish	14
Biology	11
Physics	10
Chemistry	10
English	9
Geography	9
Psychology	8
History	6
Mother tongue and literature	5
Health education	4
Philosophy	2
Religion	1
Guidance counselling	1
Total	162

easy…'). In each case, student teachers' primary teaching subject was omitted, so ultimately the number of subject-specific questions was 21. The questionnaire, originally written in Finnish, has been translated into English in Appendix 1.

The IBM Statistical Package for Social Sciences (SPSS) version 25 was used for statistical analysis of the data created with the questionnaire. The analytical process took place in three stages. In the first stage, means and standard deviations were calculated in two directions. First, the analysis was done from the perspective of each of the student teachers' primary teaching subjects. Thus, the calculations reflect how easy or difficult the student teachers estimated it is to generate integrative topics linking their own subject with all the other subjects. As a result, 15 groups were formed (see Table 3), which was the number of different primary teaching subjects. Means and standard deviations were calculated for each of these groups, although the four smallest groups were deleted to maintain the anonymity of the respondents. Then, the analysis was done from the perspective of secondary teaching subjects. In this way, it was possible to estimate the potential for also integrating those subjects not included on the list of primary teaching subjects mentioned by the student teachers. Means and standard deviations were calculated for all 22 subjects (see Appendix 1) that describe the relative ease or difficulty in generating integrative topics for each subject, as estimated by subject teachers who will not be teaching that subject as their primary subject. Finally, the subjects were compared pairwise to reveal more in detail estimations as to how easy or difficult it will be to generate integrative topics that combine the primary teaching subject with all other subjects.

After compiling the descriptive statistics in the first stage, the second and the third stages made use of statistical reasoning methods. Before the next stages, a sum variable was devised for each respondent. The sum variable describes the mean of student teachers' estimation of the relative ease or difficulty in generating

Table 5. General characteristics of the participants

Age	–24		25–29		30–34	35–	Total
	81 (34%)		84 (35%)		32 (13%)	45 (19%)	242
Gender	Female			Male		Other	Total
	170 (70%)			68 (28%)		4 (2%)	242
Basic education	Matriculation examination			Vocational qualification		Other	Total
	206 (85%)			3 (1%)		33 (14%)	242
Experience on teaching	None	Teaching practice lessons		Some substitute teaching in addition to practice lessons		Worked as a full-time teacher	Total
	2 (1%)	80 (33%)		140 (58%)		21 (9%)	243
Year of studies	First	Second	Third	Fourth	Fifth	Sixth or more	Total
	0 (0%)	2 (1%)	11 (5%)	62 (26%)	53 (22%)	114 (47%)	242

integrative topics between the primary subjects and each of the 21 non-primary subjects. Then, the normal distribution of the sum variables was investigated. Although the Kolmogorov-Smirnov test ($p = .003$) disproved the hypothesis regarding a normal distribution, it is still possible to assume a sufficient normal distribution because the skewness and kurtosis did not have values more than 3.29 times their standard error (Kim, 2013). Thus, parametric methods were used.

In the second stage, one-way analysis of variance was used to investigate the correlations between the background variables, most notably the primary (see Table 3) and secondary (see Table 4) teaching subjects, and the sum variable. In this way, the study determined whether statistically significant differences can be found between the subjects' perceived potentiality for integration or if some background variables (see Table 5) correlate with the sum variable. In addition, the effect sizes of the results were calculated.

In the third stage, exploratory factor analysis was conducted using Principal Axis Factoring extraction and Promax rotation to identify latent factors. Latent factors can reveal subject groups that correlate uniformly. The factors would then draw lines between broad fields that have the potential for internal integration. The data from all 22 subject variables were used in the analysis. Cronbach's alpha values were calculated to assure the internal reliability of the factors, and the correlation between the factors was also examined.

7 The central findings of the studies

This chapter summarises the results of the three studies that comprise this thesis. Studies I–III focus on three different types of curricula (see Table 1) but are nonetheless interrelated. Study I applies the framework of PCK to theoretically explores the kind of knowledge that teachers need when they implement curriculum integration. It shows why curriculum integration puts certain demands on teacher knowledge, which needs to be acknowledged. Study II empirically investigates integrated curriculum via student teachers' perceptions of how best to combine topics from various school subjects. It reveals how certain subjects can more readily be integrated with some subjects rather than with other subjects. Then, to address the challenges of curriculum integration and acknowledge its subject matter specificity, Study III focuses on written curricula and assesses what powerful integrated knowledge could mean at that level. Studies I–III show in multiple ways why knowledge matters in curriculum integration. The challenges of curriculum integration identified in Study I are explored as possible ways to consider knowledge-based curriculum integration in Study II and Study III.

7.1 Teacher's integrative knowledge in implementing an operational curriculum

Study I applies Lee Shulman's concept of pedagogical content knowledge to study the knowledge requirements of curriculum integration from the perspective of teachers. Study I examines different types of knowledge that can be integrated when devising an operational curriculum, what it entails from teachers and how those demands could be addressed in teacher education. It examines curriculum mainly at the operational level, i.e. how teachers can put the curriculum into practice. Study I applies Shulman's construct to define the teacher knowledge categories needed when integrating curriculum with respect to various teaching arrangements. The main conclusion is that integrative teaching increases the demands placed on a teacher's level of knowledge.

To pinpoint the content knowledge needed for curriculum integration, Study I develops the novel concept of a teacher's *integrative pedagogical knowledge*, which considers teacher knowledge domains from the perspective of curriculum integration. Four of the knowledge domains included in Shulman's construct proved most relevant for curriculum integration and are examined in detail: 1) content knowledge, 2) curriculum knowledge, 3) pedagogical content knowledge and 4) knowledge of the ends, purposes and values of education.

Shulman's domains of teacher knowledge make it possible to understand the challenges posed by curriculum integration especially for subject teachers. First,

Study I examines the role of content knowledge in curriculum integration. As the foundational idea of PCK is that good teaching is a synthesis of sufficient content and pedagogical knowledge manifested as content and context-specific teaching, teaching without sufficient content knowledge becomes problematic. This is the case with, for instance, integrative teaching, in which a teacher possesses sufficient content knowledge of only one of the subjects that needs to be integrated. Shulman (1987) claims that the better content knowledge of teachers, the more chances they have to develop good quality and versatile teaching. However, curriculum integration can have the opposite effect (see Grossman et al., 2000).

Second, Study I investigates curriculum knowledge from the perspective of curriculum integration. Shulman (1986b, 1987) splits the concept of curriculum knowledge into three sub-categories. They reveal further conditions required for integrative teaching. First, *knowledge of the alternative curriculum materials* refers to an awareness that a curriculum can be devised in multiple ways, including various types of curriculum integration. Further, it means having a knowledge of the pedagogical tools and instructional materials that can be applied, for example, in integrative teaching. Second, *vertical curriculum knowledge* enables a teacher to see how the content of a subject builds on what has previously been learned. Thus, vertical curriculum knowledge is crucial for integration within a subject. Third, *lateral curriculum knowledge* refers to a teacher's knowledge of the content that students are studying simultaneously in various subjects and to a teachers' understanding of how the contents of the different subjects are related. Shulman's explanation of a teacher's *lateral curriculum knowledge* reveals many of the challenges of integrative teaching because specialised subject teachers do not have deep knowledge of the content of the subjects that they are not teaching themselves, especially what topics are studied at certain point of time.

Third, Study I interprets just what pedagogical content knowledge might mean in integrated contexts. As noted above, PCK can manifest itself in teaching as examples, metaphors or exercises that make the content more accessible for the students to learn. As a special case, *integrative pedagogical content knowledge* refers to the pedagogical means best suited to revealing essential connections between subjects through shared content. Those connections can be made understandable, for instance, with a suitable metaphor that binds together content from two or more subjects. A precondition for integrative pedagogical content knowledge is content knowledge of the topics shared by different subjects, referred to here as *integrative content knowledge* and applied further in Study II. Finally, Study I claims that one strength of curriculum integration is that it usually has a strong purpose, for instance to advance *Bildung* as the educational objective of schooling.

Study I identifies two key problems in Shulman's conceptualisation of PCK. First, when Shulman created the concept, he was unaware of the tradition of subject didactics, which had developed a similar kind of thinking already much earlier

(Kansanen, 2009, 2011). Second, Shulman's understanding of the knowledge base of school subjects was simplistic, as he assumed that the subject knowledge required for teaching is created when teachers transform disciplinary knowledge into subject matter (Deng, 2018b). This constitutes an unrealistic notion of what teachers are capable of and ignores the role of the written curriculum in curriculum making.

Other studies have also pointed to the challenges that curriculum integration poses for teaching. For example, recent studies on implementing multidisciplinary learning modules in Finnish schools shows that they have significantly increased teachers' workloads and have demanded new skills of teachers (Haapaniemi et al., 2021; Kauppi et al., 2022; Venäläinen et al., 2020). These results are not surprising. As Palmer (1995) has claimed, the interest in curriculum integration arises time and again until it is perceived as too demanding and the focus of school development is directed elsewhere. According to Pinar (2010), the famous Eight-Year Study, which took place in the US in the 1930s, included wide-ranging experiments on curriculum integration but diminishing results because the teachers became increasingly exhausted by the constant need to reorganise knowledge (cf. Beane, 1997; Drake & Reid, 2020; see also Tyack & Cuban, 1995). Based on prior studies of curriculum integration, Gresnigt et al. (2014) have concluded that the broader the integration effort becomes, the more teacher commitment, opportunities for professional development, teacher support and school facilities are needed. Pountney and McPhail (2019) reveal that integration enhances teachers' role as curriculum makers and thus requires more subject-specific pedagogical content knowledge. As a consequence of the increasing demands and lack of curricular support, Muller (2006) presents evidence that de-differentiation of the curriculum deepens the unequal learning opportunities for students. Also, McPhail (2019) points to the increasing knowledge requirements placed on a teacher, but still argues that curriculum integration can lead to deep learning if it is sufficiently planned from the perspectives of the contributing disciplines.

The value of the theoretically oriented Study I lies in the way it elaborates on *why* integration is challenging from the viewpoint of teacher knowledge and thus helps explain the cognitive mechanisms underlying the empirical findings of other studies. As Mård and Hilli (2020) claim, the research on integrative teaching has altogether lacked theorising that could support teaching. To tackle the increasing demands placed on teachers, Study I emphasises four elements of teacher knowledge crucial for curriculum integration that can be addressed in teacher education programmes. First, teachers need knowledge about how curriculum integration represents an alternative when engaging in curriculum making. This thesis contributes to this need by providing an understanding of the knowledge-based alternative. Second, integrative teaching can benefit from teacher knowledge of the concepts bridging different subjects. To better identify how such conceptual bridge-building can take place, Study II investigates student teachers' perceptions

of integrative topics. Third, for versatile professional teaching, teachers need knowledge of the purpose of curriculum integration. Fourth, to overcome a lack of content knowledge, teachers engaging in integrative teaching need to acquire knowledge about collaborative teaching.

7.2 Student teachers' integrative content knowledge as an element of the perceived curriculum

Study II continues to employ the framework of pedagogical content knowledge (Ball et al., 2008; Shulman, 1986b, 1987) and subject didactics (Kansanen & Meri, 1999). Both traditions highlight the importance of a teacher's content knowledge for teaching, which is examined in Study II from the perspective of curriculum integration. The concept of integrative pedagogical knowledge generated in Study I is specified in Study II as *integrative content knowledge*, which refers to a teacher's knowledge of the integrative topics shared by subjects.

Study II empirically investigates the integrative content knowledge of student teachers. Thus, the study explores how student teachers perceive the integrative potential of Finnish secondary school curricula content. More precisely, it questions the extent to which student teachers perceive integration of school subjects as subject-matter specific. As the Finnish national core curriculum for basic education and for general upper secondary schools underlines the need for integrating subjects (Finnish National Agency of Education, 2016, 2020), it is important to know how the subject content can be connected across subject boundaries and the potential for collectively integrating subjects.

Collecting data on integrative content knowledge is valuable for two reasons. First, the role of content knowledge has received only marginal attention in studies on curriculum integration (Maton & Howard, 2018). Second, quantitative methods have only rarely been used when researching curriculum integration. As discussed above, certain methodological choices reveal different aspects of a phenomenon under study (Shulman, 1986a, 2004). The value of the methodological choice made in Study II lies in the way it covers all the subjects present in the Finnish secondary school core curricula. Studies applying qualitative methods have typically focused on only a few subjects. In turn, Study II provides an approximate illustration of the connections between the content of all the subjects.

The results indicate subject-specific differences in the potential to integrate various school subjects. According to the student teachers, some subjects are generally more suitable for integration because they can be connected via integrative topics with many other subjects. Other subjects, in contrast, only have a few topics in common. Mathematics generally has the most limited potential for integration, while geography can be linked relatively well with almost any other subject.

The data were first analysed via a one-way analysis of variance. Students' teaching experiences or content knowledge of many subjects did not correlate in

a statistically significant way with student teachers' readiness to generate integrative topics between subjects. This is an unintuitive finding because one would expect that teaching experience would help a teacher to find more opportunities for integration. Further, knowledge of a wider group of subjects should also supposedly increase the chance of identifying topics common to a number of subjects.

The main findings of Study II were that, first, the presence of strong differences between the integrative potential of the various subjects, and second, that the differences seem to stem from the nature of the subjects. The primary and secondary subjects to be taught correlated statistically significantly with student teachers' readiness to generate integrative topics and also with a large effect size. Thus, the subjects themselves matter, not the background variables of the student teachers. The subjects were also classified using factor analysis, which revealed four latent subject groups: 1) human sciences, 2) mathematics and natural sciences, 3) languages and 4) artistic and practical subjects. It proved clear to classify the subjects into these latent factors because the factors correspond quite well with the typical grouping of subjects in Finland (Saloviita, 2019).

The differences in the subjects' potentiality for integration can be explained in at least two ways. First, students are generally socialised into the traditions of their own disciplines during their years at university. Ideas about common collaborators and competitors are internalised when students are inducted in disciplinary ways of thinking (Ylijoki, 2000). Second, differences in the forms of knowledge themselves can explain why student teachers are more open to integrating some subjects and steering shared topics in a certain direction. Bernstein's (2000) theory of hierarchical and horizontal knowledge structures can help explain these findings. The subjects in the mathematics and natural sciences group have hierarchical knowledge structures, whereas the other subject groups are built more on horizontal knowledge structures. Generally, subjects having a hierarchical knowledge structure are perceived as more limited in their potentiality for integration than subjects with horizontal knowledge structures.

7.3 Integrating the written curriculum to support the development of powerful knowledge

As argued in Study I, curriculum integration creates various challenges when it is operationalised in teaching. Giving teachers the responsibility of designing an integrated curriculum increases the demands placed on them significantly. The same holds true for students when their role as curriculum makers expands (Kirschner et al., 2006; Kirschner & van Merriënboer, 2013; Saarinen et al., 2020; Schneider & Stern, 2010). This does not necessarily mean that integration cannot be part of curriculum implementation; but it does mean that its implementation benefits from a well-integrated written curriculum that supports the coherent organisation of educational knowledge. Therefore, Study III focuses on written curricula and

the alternatives for knowledge integration at that stage. Study III asks, how can both the maintenance and the crossing of subject boundaries enhance knowledge-based curriculum integration?

Study III draws on the concept of powerful knowledge developed by Young and Muller (Muller & Young, 2019; Young & Muller, 2010, 2013), which was discussed in section 4.1. The main claim of Study III is that if curriculum integration is interpreted as knowledge-based integration, then it is compatible with the idea of powerful knowledge. For instance, studies conducted by Garcia-Huidobro (2018), Nordgren (2021), Gericke et al. (2018) and Pountney and McPhail (2019) all posit similar conclusions. The theoretical aim of Study III was to clarify why the thinking of Young and Muller does not necessarily stand in contrast with the objective of curriculum integration, although they explicitly criticise it. This becomes evident when Study III shows that curriculum integration is not a uniform approach and that many alternatives exist for integrating curriculum in a way that respects the structures of knowledge.

Study III concludes that knowledge-based curriculum integration means enhancing curriculum coherence through both maintaining and crossing the boundaries of school subjects. Without boundaries, knowledge could not be organised and presented in any systematic or coherent form. Young and Muller (2016) highlight the role of school subjects in structuring knowledge in such a way that makes it possible to preserve their disciplinary core. Young and Muller's concept of powerful knowledge helps clarify how the maintaining of subject boundaries is crucial for a knowledge-based curriculum. However, they have not paid enough attention to the coherence of the curriculum as a whole. The overall coherence of a curriculum is important for advancing the truthfulness of knowledge in the broadest sense,[8] and for advancing students growth towards becoming educated personalities (see Carr, 2007), or towards *Bildung* (see Schneuwly & Vollmer, 2018). Furthermore, when the curriculum is written in a coherent manner, it makes it more manageable for the teachers (Hargreaves, 1991; Sullanmaa, 2020). Thus, integration is a crucial question with respect to the coherence of content both within and across subject boundaries.

As Study II suggests, it is essential to consider the knowledge content of school subjects when seeking to integrate them. It is not reasonable to cross subject boundaries at just any point; the subject matter creates specific opportunities for

[8] According to Carr (2007), modern mainstream theories on knowledge widely recognise the interconnected nature of knowledge claims. This means that the truth value of claims need to be evaluated from the perspectives of multiple disciplines. For instance, to answer the question 'what good is education?', scholars need to address it from the perspectives of the contributing educational science disciplines (see McCulloch, 2002). Curriculum coherence advances the truthfulness of knowledge in the sense that teachers and students have a better chance to successfully manage the concepts both within and between subjects, thus coming to an educated understanding of the interconnected nature of knowledge. Hence, the coherence of educational knowledge does not in this instance imply the commitment to the coherence theory of truth.

and poses certain restrictions to integration. The boundaries set their own specific boundary-conditions for boundary-crossing. Study III claims that because curriculum integration is demanding for teachers and students alike, the question of boundary maintenance and boundary crossing, or the differentiation and integration of educational knowledge, should be better dealt with at the level of the written curriculum. As Deng (2015) claims, the question of organising curricular knowledge has been largely neglected in curriculum studies during recent decades. Therefore, the issue of curriculum integration has not of late received enough attention as a question concerning the organisation of knowledge at the level of the intended curriculum.

When knowledge is organised for a specific curriculum, boundaries are drawn between subjects and content knowledge is integrated within these boundaries. At this stage, educators decide upon the number of subjects and their scope. For instance, in the Finnish core curriculum for basic education the number of subjects and the boundaries between them increases at the higher grade levels (Finnish National Agency of Education, 2016). Then, points at which to cross the boundaries can be designed in the curriculum as well. However, the planning of these boundary-crossing points is usually left to teachers. This is the case in, for example, the Finnish core curriculum for basic education, which assigns the task of planning the multidisciplinary learning modules to local schools (see Finnish National Agency of Education, 2016).

Boundary-crossing elements can also be designed in the written curriculum. For instance, boundary-crossing units or courses can be included in a curriculum at places where they can best benefit its overall coherence. The results of Study II point to places where subjects are perceived as having shared content. One possibility is to design themes for a curriculum that bind together the content of certain subjects. Klafki (1991) has proposed 'epoch-typical key problems' as themes that would integrate the perspectives of the subjects and simultaneously address complex social problems. But, as Pring (1971) claims, the integrative themes cannot be just any topics, the themes need to facilitate the coherent structuring of knowledge. Further, the written curriculum can include, for instance, diploma work or capstone courses that allow the students to apply holistically what they have learned in various subject-based studies. These kinds of alternatives can both maintain and cross subject boundaries, and thus, support the development of powerful knowledge that recognises not only the importance of a coherent structure of knowledge for school subjects but also for the curriculum as a whole. The maintenance of subject boundaries helps in integrating knowledge within the boundaries. In turn, boundary crossings enable integration of the curriculum as a coherent whole.

8 Discussion

The knowledge-based approach to curriculum integration is by no means the only possible and sensible way to examine curriculum integration. A major claim of this thesis is that the knowledge-based perspective has a long history, however it has lost its meaning in the current discussions on curriculum integration. Therefore, the role of knowledge needs to be better recognized both in research and implementations of curriculum integration. This final chapter discusses how this could be done. First, this chapter proposes potential implications of the results presented above. Then, it acknowledges some of the limitations in the scope and methodology of the thesis, suggests directions for future research and finally summarizes the main arguments of the thesis.

8.1 Implications

In this section, the potential implications are discussed first with respect to teacher education and then curriculum design. Study I makes proposals for the development of subject teacher education to better prepare student teachers for curriculum integration. It claims that the starting point for integrative teaching is that teachers have an understanding of its meaning. This will help them avoid feeling that curriculum integration is merely an external requirement or part of an international trend in education. To understand the meaning and purpose of curriculum integration, it needs to be seen as a basic question of curriculum theory. If student teachers generate sufficient understanding of the meaning and purpose of curriculum integration, then they will most likely develop integrative teaching as part of their professional knowledge.

In teacher education, student teachers should develop at least some basic understanding of the subjects that they will not be teaching themselves. If teachers do not have a grasp of the curriculum as a whole, how could it be assumed that the students would develop such an understanding? Interdisciplinary study modules can be created to increase collaboration across subject boundaries in subject teacher education (Goddiksen, 2017). Student teachers can use the modules to learn how academic disciplines work together to answer boundary-crossing research questions. Further, when working together with student teachers from other academic disciplines and collaboratively designing integrative teaching, student teachers can familiarise themselves with different academic and teaching traditions. This will help student teachers form future collaborations in schools, where teachers comprise a multidisciplinary group of professionals.

If student teachers were to gain experience in implementing at least one boundary-crossing integrative period during their teacher education training, then they

would be better prepared to integrate the curriculum in practice when working in schools. While many teacher education development projects have already addressed the issue of integrative teaching (e.g. Karppinen et al., 2013; Nikkola et al., 2013), this needs to be done more systematically. As Vollmer (2021) claims, it is necessary to create a complete picture of the network made up of different school subjects, which will assist teachers in locating spaces with more and less potential for collaboration.

Although more research is needed to explore the topics shared by subjects, the results of Study II help to identify suitable partners for building bridges between subjects. The results of Study II can be taken into account when, for instance, implementing multidisciplinary learning modules in Finnish schools or when creating interdisciplinary study modules during subject teacher education. Additionally, the results of Study II can be used to design future studies that examine in more detail the integrative potential of various subjects. Mapping the shared topics more precisely would also facilitate the development of teaching materials, such as textbooks that promote integrative topics and written curriculum that includes well-planned elements integrating the content of the various subjects.

The results of Study III should be considered especially when a written curriculum is designed. Study III clarifies theoretically how knowledge differentiation and integration, in other words boundary drawing and crossing, are basic questions of curriculum design. The most significant implication of this conclusion is the need to understand that school subjects and curriculum integration are not contradictory. Both are required for coherent curriculum design that would appropriately support the teaching-studying-learning process in schools. Further, if the claims of Study III are taken seriously, curriculum integration should be addressed more intensively as a question concerning the written curricula, which would better support the work of teachers and students.

Study III presents alternatives that can be used to integrate the curriculum with the aim of developing powerful knowledge. Perhaps the most prospective alternative described in Study III builds on Klafki's (1991) idea of a curriculum consisting of school subjects and epoch-typical key problems, which can bind together perspectives from the different subjects and thus increase curriculum coherence. The multidisciplinary learning modules in the Finnish core curriculum for basic education could be re-established around the 17 goals defined in the United Nations (2015) sustainable development agenda. The agenda includes such goals as gender equality, climate action, and peace, justice and strong institutions. These goals deal with the so-called wicked real-world problems that certainly require multidisciplinary approaches to be solved. Selecting this kind of topics as curricular content would highlight the purpose of schooling as the builder of a better tomorrow. Thus, schooling as an institution could adopt a stronger role in societal renewal. Defining topics for the modules would make it possible to coordinate subject collaboration in a manner that acknowledges just what content would

serve the integration effort best. Further, well-defined modules would make it possible to develop teaching materials. However, as Young (2021a) notes, integrative topics run the risk of being used for repressive ideological purposes. Therefore, the democratic selection of what agendas are most worthy of focus is a significant issue.

8.2 Limitations and directions for future research

In this section, the limitations of the studies and possibilities for future research are examined. The most significant limitation of this thesis is that it does not extend to the level of the attained curriculum, referring to the ways in which students experience schoolwork and the kind of learning that results. This limitation is inherent in the choice of the theoretical frameworks of the thesis, as powerful knowledge and pedagogical content knowledge relate the level of the attained curriculum only cursorily. Although this thesis does not concern itself with the attained curriculum, it needs to be noted that the study of learning does not consist of a single paradigm, and thus, does not form a uniform alternative perspective on how best to address curriculum integration. For instance, Sfard (1998) has referred to the juxtaposition of learning sciences that has divided the notion of learning into such metaphors as *acquisition* and *participation*. Further, for Engeström (2015) learning primarily means a change in the activity system of a collective. What curriculum integration can mean for learning is discussed here by pointing to some essential future research topics.

While curriculum integration has been a popular research topic for some time now, the students' perspective has been secondary. It has remained unclear the extent to which students experience the content of school subjects as either differentiated or integrated (Stevens et al., 2005). If teachers struggle with understanding integrative content knowledge, then students with lesser expertise will probably find it even more difficult. On the other hand, the subject boundaries that are quite real for teachers and researchers might not be as equally clear for students. From the perspective of the student, a typical school day is a multidisciplinary whole consisting of lessons on a few different subjects that can blur together as an undifferentiated totality (Jacobs, 1989). Further research is needed on how students experience the boundaries of school subjects.

Dewey (1902) claimed that the experiences of children are *per se* undifferentiated. However, this is not an ideal state to be maintained because mere holistic experience does not necessarily lead to the expansion of understanding. Thus, Dewey advocated for a well-organised subject-based curriculum. Cognitive science has shown that differentiating between the various elements of a task is crucial for learning (Schneider & Stern, 2010). According to Siegler and Chen (2008), successful learning becomes visible when, first, the elements of the object

of learning are differentiated, then integrated, and finally, when transferrable principles are generated. Thus, the learning process proceeds from undifferentiated experience to differentiated cognition, and only when the differentiated parts are integrated can the process be referred to as deep learning (see McPhail, 2020).

Theories of the transfer of learning have attempted to explain boundary crossings from the perspective of the learner (Shulman & Quinlan, 1996). Such theories claim that learning that has occurred in one place can be transferred to other similar situations. This sort of activity is crucial because it allows students to integrate subjects by transferring what is learned across subject boundaries. Different models have been presented on how the process of transfer materialises (Tuomi-Gröhn & Engeström, 2003). The activity-theoretical view of transfer comes closest to the idea of powerful knowledge. Like Young, it draws from Vygotsky and emphasises the formation of a theoretical relationship with reality through developing conceptual content-related abstractions. In contrast to the more individualistic theories of transfer, the activity theoretical approach stresses change at the level of a collective activity system that can promote the transfer process.

A school subject can serve as an example of an activity system. With activity theory, the learning of an individual is intertwined with change in the collective activity system (Engeström, 2015). Therefore, the key to transfer does not rest primarily in the abilities of an individual student, but in the way the various school subjects can form a shared activity system that constructs a common pitch and shared rules of the game. To use Engeström's (2000) metaphor, an integrative activity system can bring together the subjects on a common ground and allow the students to play a boundary-crossing game. The activity-theoretical view of transfer offers a direction to extend the analysis of knowledge-based curriculum integration to the level of the attained curriculum.

In addition to not focusing on the attained curriculum, this thesis has other limitations that could be addressed in future studies, both via empirical and theoretical research. These limitations include the challenges of integrative teaching, which could be studied further from an *empirical* standpoint. Further, this thesis does not concretely reveal what kinds of integrative topics shared by the different subjects have the potential to act as pathways to knowledge-based curriculum integration or what kinds of alternatives to organising curricular knowledge have been applied. Next, some potential research agendas are briefly sketched to acknowledge these limitations.

First, although the theoretical work done in Study I clarifies the knowledge demands of integrative teaching, more empirical studies are needed to further specify what kind of knowledge is key to successful integrative teaching. It would be especially interesting to discover how teachers manage to recontextualise multidisciplinary knowledge, for instance for the purpose of designing multidisciplinary learning modules, i.e. what types of solutions teachers have found to designing content for the modules that is not defined by the curriculum.

Second, the alternatives for curriculum design presented in Study III could be empirically compared to how knowledge is organised in various written curricula. Study III addresses both the place of subject boundaries and spaces where it is possible to cross such boundaries to create a more integrated curriculum. To examine how written curricula differentiate between and integrate knowledge via subject boundaries, their subject structures can be compared both historically and internationally. Further, it would be interesting to investigate what kinds of alternatives to boundary crossing between subjects have been devised for such curricula. This analysis would reveal the extent to which the integration of educational knowledge is addressed on the level of written curricula.

Third, Study II collected data on student teachers' perceptions of integrative topics between subjects. The analysis shows clear and statistically strong results, but they need to be taken with caution and cannot be generalised. Study II only covers student teachers' views. Future research can repeat the study with in-service teachers and compare the results. Previous research suggests that student teachers are generally more open to the idea of curriculum integration than are in-service teachers (Karppinen et al., 2013).

Fourth, both Study II and Study III suggest that future research should examine in detail the topics shared by different school subjects. This can be done in several ways and with varying scope. One possibility is to ask teachers to identify shared topics between individual subjects or within the four subject groups already formed in Study II. A broader project would be to map, for instance, the subject content of the Finnish core curriculum for basic education and draw a network of linkages between subject content at different grade levels. In addition to curriculum documents, textbooks and other material that elaborate on the content could be studied. For example, Antoniou (2021) found that explicit connections were rare and superficial in Greek curricula and educational materials. Further, Wan and Lee (2021) studied Taiwanese and Korean integrated science subject textbooks and concluded that coherence of content can be achieved through a well-planned sequence of disciplinary concepts that simultaneously avoid an overdose of content and support learning through conceptual buttresses. Mapping shared integrative topics would make it possible to develop a more coherent curriculum, in which the subject content as a whole is structured to support the teaching-studying-learning process. However, it would be not enough to look only at the content of the subjects, which is usually designed to enhance coherence within a subject and not to advance broader curriculum integration (Westbury, 2008). It would be useful to explore disciplinary knowledge that could be recontextualised in the curriculum for boundary-crossing purposes. Sources for these types of topics could be found especially from interdisciplinary research fields (see Klein, 1990).

Fifth, integrative topics could also be explored by studying the kinds of topics that Finnish schools have chosen for their multidisciplinary learning modules. According to the Finnish national core curriculum for basic education (2016), the

modules should include elements from the various subjects. Therefore, the topic included in the modules would reveal just what connections have been considered most useful in different school communities. During the first years of implementing a new curriculum, popular topics have been connected especially to the centennial of the Finnish independence and to sustainability issues (Venäläinen et al., 2020). Detailed analysis of integrative topics could also cover the local curricula used in general upper secondary schools, which are now being encouraged to develop courses that integrate perspectives from various subjects (Finnish National Agency of Education, 2020).

Finally, curriculum integration could be included more systematically as a research area in the developing theory of *general subject didactics*. For the development of theory, future research can expand on the theory of subject matter didactics to include curriculum integration as one of its key areas of interest. Since integration always touches on more than one subject, it inevitably needs to be dealt with at a more general level. Currently, a general theory of subject didactics is still being developed (Rothgangel & Vollmer, 2020; Vollmer, 2014, 2021). Bearing many similarities with Shulman's PCK, it aims to generate a meta-theory of individual subject didactics regarding content-specific teaching and learning. The theory of subject didactics transcends the perspectives of individual subjects and builds a comprehensive picture of subject-based education through comparative research. It looks beyond the boundaries of the subjects and explores cross-sectional topics that various subjects can address collaboratively (Rothgangel & Vollmer, 2020).

As Study I suggests, integrative didactics could form a subfield of general subject didactics. Integrative didactics could build a systematic foundation for future research on knowledge-based integration. Its main responsibility would be to enhance both vertical and horizontal coherence of the curriculum as a whole. A major task of integrative subject didactics would be to chart the connective topics that could serve as boundary-crossing points between the subjects and generate alternatives for curriculum design.

8.3 Why knowledge matters in curriculum integration

This thesis clarifies the meaning of knowledge-based curriculum integration and elaborates on what implementing such a curriculum entails at the level of teaching and curriculum design. It distinguishes between the knowledge-based approach to curriculum integration and an interpretation of curriculum integration that treats the boundaries of school subjects as obstacles to good learning. Implementing a knowledge-based integrated curriculum means that the integration of educational knowledge takes place both within the boundaries of school subjects and advances the coherency of the curriculum as a whole by crossing the subject boundaries in appropriate places through integrative topics shared by two or more subjects.

Prior research on knowledge-based curriculum integration has introduced many of the ideas discussed here. Especially the work of Pring (1971, 1976) is much in line with the findings of this thesis. However, as the focus of curriculum studies has shifted from research on curriculum development to curriculum as activity (Connelly & Xu, 2010), current understandings of the meaning of curriculum integration have largely ignored the question how best to organise knowledge for a coherent curriculum. Therefore, this thesis re-introduces the question how to structure knowledge when designing an integrated curriculum and expands on the previous conceptions of knowledge-based curriculum integration by connecting the question of organising knowledge with questions regarding teaching praxis, or as Petrina (2004) put it, it binds together the politics of content knowledge and the 'realpolitik of form'. This thesis reconstructs the meaning of knowledge-based curriculum integration and identifies suitable directions for future research by pointing to just what challenges and potentials knowledge brings to curriculum integration.

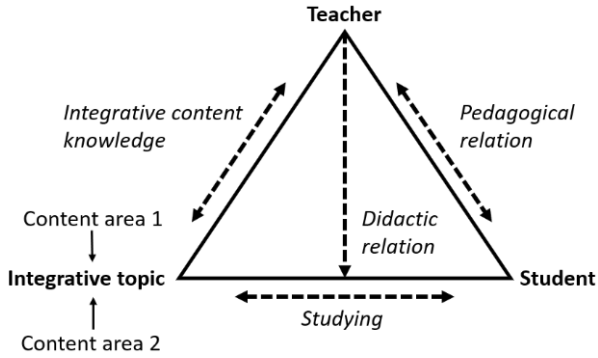

Figure 1. Knowledge-based integrative teaching-studying-learning process (Kansanen, 2003 applied).

Figure 1 summarises the knowledge-based approaches to curriculum integration at the level of an implemented curriculum. It underlines the integrative topics between school subjects as vehicles driving the integrative teaching-studying-learning process. Figure 1 utilises the traditional didactic triangle (Kansanen & Meri, 1999). The angles of the triangle consist of the teacher, the student and the content, all of which are interconnected. The relationship between the teacher and the student is pedagogical. According to Kansanen (2003), values, general goals and the construction of meaning form the central elements of the pedagogical relationship. One objective of the pedagogical relationship is to motivate the student to form a relationship with the educational content, i.e. to begin the conscious process of studying. In the distinctive institutional context of schooling, learning is pursued through the purposive process of studying. The curriculum sets the general direction by defining the content to be studied, and the teacher guides the studying process via didactic relations, meaning the teacher's relationship to the relationship between the student and the content. The didactic relationship covers

content-specific teaching practices that aim to help the student grasp the content via studying. The meaning of the didactic relationship comes close to what Shulman referred as a teacher's pedagogical content knowledge.

The basic idea of the triangle does not necessarily change drastically in an integrated context. It reveals the special kind of content knowledge needed in integrative teaching. For the didactic relationship to be formed, a teacher needs to have integrative content knowledge of the topic a student is studying. The knowledge-based approach to teaching, represented by the idea of pedagogical content knowledge and subject didactics, claims that good teaching is based on a teacher's knowledge of the content to be studied. Thus, integrative teaching requires that a teacher has knowledge of how two areas of content can be integrated via a common topic. As studies I–III show, it cannot be taken for granted that teachers would have sufficient integrative content knowledge of the topics shared by different subjects, or that all the subjects could be equally integrated. Therefore, to enable teachers to teach a knowledge-based curriculum, the development of integrative content needs special attention.

To study the role of knowledge in curricula and teaching, this thesis draws from the works of Michael F.D. Young, who has focused primarily on the level of the intended curriculum, and Lee Shulman, who has focused on the efforts of teachers at implementing a curriculum. This thesis has argued that the works of Young and Shulman offer mutually complementary ways to explore what knowledge-based curriculum integration entails. Young's concept of powerful knowledge and the theory of social realism concentrate mainly on the curricular recontextualisation of disciplinary knowledge as school subjects. In turn, Shulman's framework of pedagogical content knowledge has focused on the pedagogical recontextualisation of knowledge via teaching (see Table 2). Together, these two theories help explain the role of knowledge, first, in curriculum design, and second, in the operationalisation of the curriculum as subject teaching. Since the thesis focuses on the levels of intended and implemented curriculum, the experiences of the students and learning outcomes remain beyond its scope, but they are nonetheless relevant topics for future studies.

This thesis offers three main conclusions. First, curriculum integration is challenging for teachers because it expands the demands placed on their knowledge of multiple subjects. Second, curriculum integration is subject-matter specific. Some subjects can be integrated more easily than other subjects. Third, since curriculum integration is challenging and subject-matter specific, it needs to be addressed more explicitly when designing a written curriculum. Many alternatives exist for integrating the various parts of a written curriculum to make it a coherent whole.

The most pressing future research questions arising from these conclusions concern the need to specify what kinds of concepts, problems or contexts can act as integrative content within and across subject boundaries. Just as it is important

to plan the structure of school subjects in a way that fully supports the teaching-studying-learning process, so too is it crucial to plan how the subjects can work together to meet shared educational aims. In other words, both the differentiation and integration of educational knowledge are basic questions surrounding curriculum design. The dynamic of these questions has the potential to be better addressed when designing a written curriculum that can support the integrative teaching-studying-learning process in schools. If the formation of school subjects is not left to teachers and students, how then could it be supposed that they could manage the challenging task of curriculum integration?

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Appendix

Appendix 1. The questionnaire for Study II

You are most welcome to take part in the survey! All data will be stored anonymously. It takes about 5 minutes to answer all the questions. The questionnaire has three pages. Questions marked with an asterisk * must be answered. We begin with background questions, followed by subject-specific questions.	
Age	o –24 o 25–29 o 30–34 o 35–
Gender	o Female o Male o Other
Basic education	o Matriculation examination o Vocational qualification o Other
Experience working as a teacher	o None o Teaching practice lessons o Some substitute teaching in addition to practice lessons o Worked as a full-time teacher
Year of studies	o First o Second o Third o Fourth o Fifth o Sixth or more
Choose the subjects you are planning to teach based on the qualifications you plan to acquire. The subjects included in the basic education curriculum and the general upper secondary curriculum are included in the questionnaire.	
Primary teaching subject*	o Mother tongue and literature o Swedish o English o Other foreign language o Mathematics o Biology o Geography o Physics o Chemistry o Health education o Religion o Ethics o History o Social studies o Music o Visual arts

	○ Crafts ○ Physical education ○ Home economics ○ Guidance counselling ○ Psychology ○ Philosophy
Second teaching subject	Same 22 choices as above
Third teaching subject	Same 22 choices as above
Fourth teaching subject	Same 22 choices as above

From the perspective of your primary teaching subject, think about topics that connect it with other subjects. Below is a separate question for each subject.

How easy or difficult do you think it is to generate topics that link your primary teaching subject with other subjects?

For example: My primary teaching subject is history, so I need to consider what topics link history with the subjects of mother tongue and literature, chemistry, crafts, and so forth.

Topics linking my primary teaching subject with **mother tongue and literature** are*	○ Very difficult to generate ○ Difficult to generate ○ Easy to generate ○ Very easy to generate
Topics linking my primary teaching subject with **second national language** are*	Same 4 choices as above
Topics linking my primary teaching subject with **English** are*	Same 4 choices as above
Topics linking my primary teaching subject with **other foreign languages** are*	Same 4 choices as above
Topics linking my primary teaching subject with **mathematics** are*	Same 4 choices as above
Topics linking my primary teaching subject with **biology** are*	Same 4 choices as above
Topics linking my primary teaching subject with **geography** are*	Same 4 choices as above
Topics linking my primary teaching subject with **physics** are*	Same 4 choices as above
Topics linking my primary teaching subject with **chemistry** are*	Same 4 choices as above
Topics linking my primary teaching subject with **health education** are*	Same 4 choices as above
Topics linking my primary teaching subject with **religion** are*	Same 4 choices as above
Topics linking my primary teaching subject with **ethics** are*	Same 4 choices as above
Topics linking my primary teaching subject with **history** are*	Same 4 choices as above
Topics linking my primary teaching subject with **social studies** are*	Same 4 choices as above
Topics linking my primary teaching subject with **music** are*	Same 4 choices as above
Topics linking my primary teaching subject with **visual arts** are*	Same 4 choices as above

Topics linking my primary teaching subject with **crafts** are*	Same 4 choices as above
Topics linking my primary teaching subject with **physical education** are*	Same 4 choices as above
Topics linking my primary teaching subject with **home economics** are*	Same 4 choices as above
Topics linking my primary teaching subject with **guidance counselling** are*	Same 4 choices as above
Topics linking my primary teaching subject with **psychology** are*	Same 4 choices as above
Topics linking my primary teaching subject with **philosophy** are*	Same 4 choices as above

If you agree to be interviewed later, enter your email address below. You will receive a Unicafe gift card as a reward for participating in the interview.	Text entry
My answers may be stored in the archives of the Social Science Data Archive and made openly available for research use.	o Yes o No

I

Chapter 8

Teachers' Knowledge of Curriculum Integration: A Current Challenge for Finnish Subject Teachers

Mikko A. Niemelä and Kirsi Tirri

Additional information is available at the end of the chapter

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Abstract

The purpose of this chapter is to explore and analyze the kind of knowledge curriculum integration (CI) required of teachers and how teacher education should be developed to prepare teachers better for CI. The chapter is organized as follows: first, the concept of CI is briefly introduced in the context of the Finnish curriculum for comprehensive schools. Then Lee Shulman's theory of teachers' knowledge is discussed and applied to the framework of CI to identify the challenges teachers may face in implementing it. Finally, implications for teacher education are suggested based on the current challenges identified in the Finnish context.

Keywords: curriculum integration, pedagogical content knowledge, Finnish national core curriculum for basic education, teacher education, subject teaching, secondary school

1. Introduction

Currently, active discussion of curriculum integration (CI) is taking place in Finland, because a new core curriculum for comprehensive schools has been implemented since 2016 [1]. For the first time, the new core curriculum presents CI normatively as a compulsory element of schoolwork. Earlier curricula have presented CI as a general objective to be considered by teachers in planning their teaching. At present, every comprehensive school in Finland is planning and implementing its own integrated learning modules.

The change is demanding, especially for secondary school teachers, who are specialized in teaching one or a few subjects, yet now are expected to create integrated learning opportunities

by connecting a number of subjects. This chapter acknowledges the current challenge for Finnish teachers and provides some suggestions for schoolwork and teacher education for how teachers can better meet the demands of CI. The aim is to provide concrete answers to the following research questions: (1) what kind of knowledge does CI require of teachers, and (2) how should teacher education be developed to give teachers better readiness for CI?

This chapter offers a theoretical contribution to pinpointing the challenges of implementing CI in schoolwork from the subject teachers' perspective. Lee Shulman's theory of teacher's knowledge [2, 3] is used to identify the challenges of CI for teachers in the context of the new Finnish core curriculum. Shulman's theory is useful here, because it describes categories of teachers' knowledge required for successful teaching. In this chapter, the most relevant Shulman's categories are briefly described, followed by a discussion of how these categories change in integrated contexts. Finally, some concrete suggestions are provided to include CI in teacher education programs.

2. Curriculum integration and the Finnish national core curriculum for basic education

CI played a strong role in the first Finnish core curriculum, written for comprehensive schools in 1970. The curriculum even included a plan of comprehensive school based completely on an integrated curriculum [4]. This plan was not realized, and CI was of less importance in the curricula that followed, which were published about once a decade, although the debate on CI was significant during the reforms [5]. The new *National Core Curriculum for Basic Education* is again strengthening the role of CI. Today, the implementation of CI is explicitly compulsory for all Finnish schools. Every school year has to include at least one multidisciplinary learning module lasting approximately 1 week. Additionally, the curriculum includes a list of seven cross-curricular transversal competences, such as multi-literacy and ICT competence, which are to be taught in connection with every subject [1].

Even though CI has been a feature of the Finnish comprehensive schools for almost half a century and is recognized as valuable by teachers, research shows that its implementation has not met the curriculum objectives [6, 7]. These results call for new studies of CI to develop teachers' work to meet the current demands. However, it has to be pointed out that this is not only a pedagogical issue, but also a social one. Lopes and Macedo [8] describe a subject-based curriculum as a form of control that sustains prevailing labor relations, knowledge processes, and the creation of identities and therefore resists change. Subject teachers form interest groups promoting particular subjects [9]. CI, however, does not have this kind of interest group behind it. Additionally, challenges connected to curriculum reform in general have an effect on implementation of CI, such as teachers' extensive workload, lack of curriculum knowledge, experience of top-down leadership of the reform, and insufficient resources for planning [10].

School curricula are usually organized around school subjects with notable similarities from country to country. This is sometimes taken for granted, yet the organization is a result of

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a long social process involving struggles with curriculum content [9]. CI can be seen as an alternative way of organizing schoolwork. Sometimes a school subject has a scientific discipline as a background, such as biology, although the science of biology is divided into many subcategories. A school subject can also be a cluster of many fields of knowledge. An example is environmental studies, which in Finnish primary school is a combination of biology, geography, physics, chemistry, and health education.

For example, in the Finnish system, students in grades one to six are given environmental lessons; by grades seven to nine—lower secondary school—environmental studies change to more specific science subjects. The older the students become, the more subject-based the schooling becomes [1]. This is significant both from the students' and from the teachers' points of view. In Finnish primary schools, teachers are usually giving instruction in the majority of the subjects, but in secondary schools, only one or a few subjects. In this chapter, the main emphasis is on secondary level education and the challenges CI presents for subject teachers at this level.

CI is generally seen as a process of teaching and learning that crosses the unnecessarily strict boundaries of school subjects, making connections among them. Integration can cover both content and/or process of learning [11, 12]. Content is integrated when contents of different subjects are in some way connected. How deeply the subjects are integrated can be described as a continuum, starting with studying subjects in parallel in order to view a theme simultaneously from multiple perspectives; the integration can also go as far as the complete abandonment of school subjects [13, 14]. In turn, process integration occurs, for instance, when the cognitive side of learning is entwined with the experiential. The Finnish *National Core Curriculum for Basic Education* describes the purpose and process of CI in the following way:

> *The purpose of integrative instruction is to enable the pupils to see the relationships and interdependencies between the phenomena to be studied. It helps the pupils to link knowledge of and skills in various fields, and in interaction with others, to structure them as meaningful entities. Examination of wholes and exploratory work periods that link different fields of knowledge guide the pupils to apply their knowledge and produce experiences of participation in the communal building of knowledge. This allows the pupils to perceive the significance of the topics they learn at school for their own life and community, and for the society and humankind. In the learning process, pupils are supported to structure and expand their worldview ([1], p. 32).*

The core curriculum mixes CI to some extent with inquiry learning. However, each can be realized independently. Furthermore, it presents CI as a way to enhance the social function of education. The issues of the community, the society or the humankind are usually so-called wicked problems, such as city planning, poverty or climate change. The concept of wicked problems refers to complicated issues that are hard to define, do not have a single solution, and are usually studied in various scientific fields. Planning of a school curriculum is in itself one example of a wicked problem [15]. The answers to fundamental questions of our age or of individuals seeking guidance in living must be sought in multiple sources. In schools, this can be called a didactic process, if mere adoption of knowledge is coupled with the aims of *Bildung*, i.e., creating personal significance and continuously developing a worldview [16].

Put concretely, the core curriculum mentions four ways of organizing cross-curriculum learning or even abandoning subject borders [1]. First, integration can be achieved through activities such as theme days, events, campaigns, study visits, or school camps. Second, longer integrated study modules can be created around a theme by combining the perspectives of various subjects. Third, integrated cluster subjects can be formed, for example, a science cluster that includes mathematics, physics, and chemistry. The fourth and most radical way is to organize all schoolwork holistically without any designated subjects. This is a common practice at the pre-school level in Finland.

However, to consider CI as the opposite of subject-based education would be incorrect. Integration can be seen as a normal feature in the pursuit of knowledge whenever teachers are constructing cross-disciplinary concepts in a subject-based curriculum [17]. The core curriculum offers two concrete examples of integration structured on differentiated subjects [1]. First, studies can be taught in parallel in such a way that one theme is studied simultaneously in different subjects, for example, climate change along with social studies, chemistry, and geography. Second, themes can be sequenced inside a single subject or between subjects so that a topic is learned along a continuum; an example would be studying Middle Eastern religions first in religious studies followed by the rise of the Islamic Empires and the Crusades in history.

3. Teachers' integrative knowledge

Lee Shulman has described the development of teacher education as a process in which pedagogical knowledge has become more and more openly acknowledged as essential competence along with subject matter content knowledge. However, according to Shulman, not enough attention has been given to the pedagogical skills necessary for teaching certain subject contents. Shulman's point is that pedagogical knowledge has been seen as too general, applicable to teaching any subject and all content. Instead, Shulman stresses the importance of pedagogical knowledge with which teachers can teach specific content in different subjects. The content of every subject needs its own pedagogical approach, i.e., *pedagogical content knowledge* to make it comprehensible to students. This is what Shulman has called *the missing paradigm* [2], although it has been argued that the paradigm has not been entirely missing, because it has long been a central feature of the German tradition of subject didactics (*Fachdidaktik*) [18].

Shulman presented his argument three decades ago, and the tradition of didactics has a much longer history. In Shulman's theory and in the tradition of subject didactics, the pedagogical questions of school subjects have been widely discussed, but pedagogies of CI have been taken up to a much lesser degree. Additionally, the recent discussion on development of teacher's competences has been bind to subject teaching [19]. This can be called *the missing paradigm of today*. There are many manuals of CI and reports of experiments on CI, but the question of what kind of pedagogical knowledge CI requires from teachers is rarely answered. Generally, researchers have been more interested in well-working performance than in the knowledge base and reasoning of teachers [20].

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As Kansanen [18] states, Shulman's model fits research purposes well, and the tradition of didactics acts more as a normative basis for teachers in their work. Although Shulman has been criticized for a static understanding of the meaning of subject matter [16], there are many reasons why in this chapter Shulman's theory is applied to the study of the challenges of CI. First, Shulman's theory of teachers' knowledge serves as a clear model for analyzing the requirements of teachers' work. Second, Shulman is open to the idea of CI, although he does not examine it from the viewpoint of teachers' knowledge. In any case, Shulman sees CI as one possible way of constructing a curriculum. However, he claims that if CI is taken seriously, it will have profound consequences when the discussion of how a scientific discipline becomes a school subject changes to something else [21], because if a curriculum is integrated, then there are no longer subjects with parallel disciplines. Finally, his examples come mostly from secondary schools. This suits the level of interest in this chapter.

The strategy in this chapter is to examine the effects of CI on different categories of teachers' knowledge. We discuss four Shulman's categories that are most relevant from the viewpoint of CI: (1) content knowledge, (2) curriculum knowledge, (3) pedagogical content knowledge, and (4) knowledge of educational ends, purposes, and values. Shulman presented interdisciplinarity as a part of content and curriculum knowledge [22]. He has not explained all these knowledge categories at length and has used them in an inconsistent way in different texts [23]. For those reasons, some of categories are seen to be partly overlapping [24].

In this section, another category is added as the aforementioned knowledge categories are interpreted and discussed from the perspective of CI. This category can be called *integrative pedagogical knowledge*, which crosses all categories. It is not an independent knowledge category, but an approach to each category from the perspective of CI. It is an addition to Shulman's subject-centered theory. The following sections describe what kinds of integrative pedagogical knowledge teachers need in order to implement CI. In short, teachers need understanding of CI as one option for constructing a curriculum, and they need broad knowledge of the current curriculum, including the content and objectives of subjects they are not teaching themselves. For CI to be successful, its purpose has to be clearly comprehended. Furthermore, in collaborative forms of CI, teachers need good skills and conditions for cooperation across subject borders.

3.1. Content knowledge

Content knowledge refers to teachers' awareness of the facts and the structure of their subject(s). In addition, a teacher must know why these are the accepted facts in a given field, how knowledge is constructed, why some aspects of the field are more important than others, what alternative understandings of a subject exist, how the facts are related to other concepts within and outside of the discipline, and why these things are worth knowing in the first place [2, 3]. Shulman does not problematize the relation between scientific disciplines and school subjects. In this way, the fundamental question of content knowledge is left open. According to Stengel [25], Shulman assumes that disciplines precede school subjects and that the task of teachers is to modify disciplinary content knowledge into learnable form, i.e., transform it into a school subject.

Thus, Shulman's assumption about the relation of disciplines and school subjects seems to be inadequate. Direct transformation of a scientific discipline into a school subject is hardly a reality, even with subject teachers who have received a disciplinary education. It would be practically impossible for a teacher to know a discipline so thoroughly and coherently that s/he could simply transform it into a school subject [25]. For example, a subject teacher who graduated as a history major might have strong content knowledge of the Cold War period, but only fragmented knowledge of antiquity. However, history as a school subject should cover all relevant historical periods, not just those in which a teacher has specialized. Thus, the content to be studied is more than or different from teacher's disciplinary knowledge.

Shulman [3] is aware of how teachers' content knowledge is not equally distributed to cover all aspects of a subject. He shows an empirical example of how teaching becomes different when instruction based on good content knowledge changes to subject content with which a teacher is not well acquainted. Rich, versatile teaching then turns into rigidly planned, inflexible pedagogy. Thus, the better content knowledge a teacher has, the better chances there are to develop a good level of pedagogical content knowledge. This is why it is worth spending a bit more time to consider what content knowledge really is.

The most common assumption about the origin of knowledge for teaching is the one Shulman presents, namely, that scientific disciplines are transformed into school subjects [25]. This is the case in teacher education programs, such as in Finnish subject teacher education, in which student teachers study scientific disciplines at the university level and are educated as specialists in certain disciplines and then equipped with pedagogical knowledge. However, Lopes and Macedo [8] claim that there is not necessarily a relationship between scientific disciplines and school subjects. They represent school subjects as autonomous communities that are socio-politically constructed and constantly mutating. The social objectives of school subjects are viewed differently than the objectives of science.

If the content of content knowledge does not come directly from scientific disciplines, then content knowledge should be considered as leaning on other sources, such as a curriculum, textbooks, teachers' guides, and media. It is beyond dispute that scientific disciplines and school subjects are somewhat symmetrical and that part of teachers' content knowledge comes from specific disciplines, especially the deeper knowledge of alternative views and competing theories within a discipline. However, to answer the question of why some things are worth knowing, for instance, one might look for very different explanations in school contexts as opposed to the contexts of scientific inquiry.

According to Deng [26], an integrated curriculum distances school subjects from scientific disciplines. If subjects are integrated into broader clusters, the new integrated subjects might create their own fields of knowledge without a corresponding scientific discipline. Deng uses science and technology studies as an example of a commonly integrated subject. However, Deng does not point out that disciplines can also be integrated into a form of interdisciplinary science. It is not rare to find interdisciplinary science programs combining natural sciences and technology. Thus, CI might find correspondence in interdisciplinary science projects. Another question is how these kinds of studies affect teacher education and the development of teachers' content knowledge. We will return to this question in the last section.

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Although Shulman sees teachers' ability to relate the content knowledge of a subject(s) to other subjects as a part of content knowledge, it is hard to guarantee that teachers have the necessary capabilities to do that. As mentioned above, in teacher education programs subject teachers are specialists in one or a few disciplines, and student teachers do not necessarily have any contact with subjects other than their own except for what they learned in their own school days. As Gardner and Boix-Mansilla state [27], if one does not have enough content knowledge of the subjects to be integrated, CI can be degraded to a pre-disciplinary level, the work based on common sense instead of expertise. Kysilka [13] has indicated that the lack of disciplinary knowledge is a problem for subject teachers as well as for primary school teachers, whose knowledge of the subjects might be too shallow to enable real integration. If the ability to relate is taken seriously as part of teachers' content knowledge, then some interdisciplinary studies will be required in teacher education, a topic discussed in the last section.

3.2. Curriculum knowledge

By curriculum knowledge, Shulman means teachers' broad comprehension of school subjects and an understanding that the current one presents only one way of constructing a curriculum. Curriculum knowledge includes awareness of various instructional materials, teaching procedures, and learning objectives. Teachers commonly use different kinds of curricular materials from which to pick suitable tools. It is important that teachers realize that they could pick other tools as well, that alternative learning methods are available, and that there are different ways to structure a course or a curriculum, for example, in an integrative way. This *knowledge of alternative curriculum materials* is the first of three different forms of curriculum knowledge Shulman explains. The other two are *lateral* and *vertical curriculum knowledge*.

By *lateral curriculum knowledge*, Shulman refers to teachers' ability to know what the students are learning in various subjects simultaneously. Here Shulman makes a general assumption by stating that he expects professional teachers to be aware of what students are doing outside of a teacher's own classes [2]. He also points out that for comprehension of their own subject matter, teachers would need to know how the concepts are related to other school subjects as well [3]. These are admirable objectives, but it can be asked how far this ideal is from the current reality of schools and teacher education. If the content of subjects that are not one's own is alien to teachers, then it can be posited that there are no means of knowing what is being learned in other subjects, especially simultaneously. In addition, Rogers [28] stresses teachers' profound identification with their own subject subcultures, including their particular beliefs, norms, and practices. These aspects are usually in the form of tacit knowledge, which guides everyday work, yet is not simple to express. Without knowledge of these subcultures, cross-curricular coordination can be restricted.

Lateral curriculum knowledge makes high demands of subject teachers and requires sharing information within schools. Yet, such knowledge is one prerequisite for CI in its many forms. *Vertical curriculum knowledge* in turn refers to teachers' knowledge of what has been previously taught in one's subject(s) and what will be taught in the future [2]. Such knowledge is a starting point for integration within a single subject with the goal of making the content of one subject more interconnected and experienced as a whole in students' consciousness. With history

once again as a simplified example, vertical curricular knowledge includes comprehension of how certain historical phenomena intertwine and ultimately create a new phase in history, such as industrialization together with globalization, which serves as a pathway to modernity. If lateral and vertical curriculum knowledge are applied together to integrate the curriculum, the process can advance step by step, beginning with studies of force in physics, metalwork in crafts, continuing with historical and economic significance of the steam engine followed by geographical understanding of urbanization and the development of logistics leading to globalization, then drawing the conclusion historically—the birth of the modern world.

3.3. Pedagogical content knowledge

The third kind of pedagogical knowledge essential for CI is teachers' ability to make content comprehensible to students. However, mere comprehension is not enough; according to Shulman, true learning is also linked to judgment and action [3]. This is what is called *pedagogical content knowledge*. It includes examples, metaphors, analogies, illustrations, activities, assignments, and demonstrations that make the content more accessible. This kind of knowledge also means understanding what makes learning of certain kinds of content difficult and what the common misconceptions are. Such pedagogical methods are always content-specific so they cannot necessarily be transferred to other contexts [2].

Shulman argues that pedagogical content knowledge is the area that separates a teacher from an expert in a given scientific discipline [3]. An expert might have a great deal of content knowledge, but a teacher knows how to present the information in a suitable way for school learning. However, as noted above, the substance of the content knowledge of an expert and that of a teacher are probably different, because scientific disciplines and school subjects are not constructed identically.

The relation between content knowledge and pedagogical content knowledge is not one-way. In addition to content knowledge that is refined into pedagogical content knowledge, the content of school subjects can be constructed on pedagogical bases. Content may be designed for certain age groups, as happens in the Finnish school system: the integrated subject taught as environmental studies in primary school is differentiated into natural sciences in secondary school. This is an example of how CI serves as a form of pedagogical content knowledge. A school subject is designed as an integrated whole with the aim of making the content more comprehensible to young students.

Often CI means studying contents of several subjects in connection. This means that the understanding of pedagogical content knowledge cannot be bound only to subjects, but also involves building bridges between subjects. At that point, it becomes *integrative pedagogical content knowledge*. A teacher has to have in mind demonstrations or activities that show how different subjects are interrelated or even build on knowledge from other disciplines, as in the above-mentioned example of the birth of modernity. Another possibility is to use the methods of co-teaching, collaborating with other teachers, who combine the special pedagogical content knowledge of their respective subjects. Then communication and shared understanding between teachers becomes crucial. However, the challenge for integrative co-teaching is that, in Finnish schools, it has been seen mostly as an instrument for inclusive education rather than being considered primarily in the context of CI. Research shows that co-teaching is rarely

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implemented as a collaboration between subject teachers, but is more often concentrated on using special education teachers as partners [29].

When CI is implemented with the methods of inquiry learning, the learning process and the content might not be securely in the hands of a teacher, if the students decide a theme. Then the content is not known beforehand, and building of pedagogical content knowledge can be seen as a challenging task because the content part is missing. Shulman claims that in student-centered learning, the importance of the teacher's grasp of the study content becomes even greater than in teacher-centered approaches. Shulman notes that the student-centered approaches require a strong capacity for sympathetic interpretation and transformation of content into representations [3]. In student-centered approaches, a teacher needs a deep understanding of what is being learned to enable the learning process to progress in an indeterminate direction. That being said, we can conclude that if CI is implemented in a way that a theme is selected about which teachers do not have enough content knowledge, there is no chance of developing adequate pedagogical content knowledge, and therefore, the process is likely to fail. Accordingly, if the process of CI is to be actualized successfully, then even more focus has to be put on development of teachers' content knowledge.

3.4. Knowledge of ends, purposes, and values of education

Shulman claims that normative and theoretical knowledge of ends, purposes, and values of education is perhaps the most important part of teachers' scholarly knowledge. This includes images of what is possible, of how a well-functioning school might look, what the students should become, and what can be understood as comprising a good education [3]. The Finnish core curriculum stresses the holistic growth of students as ethical persons. For teachers to cultivate moral and social awareness in students, the prerequisite is that teachers have a good understanding of educational values and purposes. In addition to general educational values, subject-specific values can be recognized [30]. Accordingly, CI can be seen as having its own, although varying value base.

The need for an integrated curriculum frequently emerges from ethical or social issues. It can even be directly aimed toward solving problems of the society or the local community. For example, CI is now popular in Finnish schools as a means of teaching what climate change means and what can be done to stall, if not reverse it. In addition, CI can serve as a form of democratic education [31, 32]. Altogether, it can be said that the strength of CI is that it can have a strong purpose, a pedagogical mission. Therefore, CI can be seen as an idealistic form for a curriculum [10]. However, for CI to be successful, the purpose has to be fully comprehended by teachers, a situation that might not always be the case in Finland, where CI has not had a stable role in teacher education [33].

4. Finnish subject teacher education and curriculum integration

Teacher education has a decisive role to play in developing teachers' *integrative pedagogical knowledge*. In this last section, the challenges identified by applying Shulman's categories of teachers' knowledge are discussed in the framework of subject teacher education with

the objective of generating suggestions for how teacher education in universities could be developed to equip teachers with information, the abilities, and the will to implement CI as described in the new Finnish core curriculum.

The analysis of Shulman's categories revealed aspects to be considered when subject teacher education is developed from the perspective of CI. Primarily, student teachers have to be aware of CI as one alternative for structuring the curriculum. This means knowledge of general curriculum theory, including CI. It is important for student teachers to know that a curriculum is historically constructed and that subject division is only one form of its actualization. This information is crucial when teachers are constructing local curricula based on the core curriculum.

Another required form of curriculum knowledge concerns the content of the current curriculum. To apply CI successfully, student teachers need to have at least preliminary knowledge of contents of subjects they are not teaching themselves. Without this kind of knowledge, it is difficult to plan teaching that connects various subjects. It is a prerequisite for individual teachers to be able to build conceptual bridges between their subjects and other subjects. In addition, broad curriculum knowledge promotes collaboration when teachers can identify the intersections of subjects. These intersections can serve as a basis for integrative themes.

According to Shulman, a sound level of content knowledge is required for developing pedagogical content knowledge. However, subject teachers cannot be an expert in all subjects. It is a challenge for every teacher to master even a preliminary understanding of all subjects. One approach is to design instructional materials that would assist in building conceptual bridges between subjects. Furthermore, building a better content knowledge base for CI could be an objective for teacher education, although it has been suggested that student teachers should first develop subject-based knowledge before getting into CI [33, 34].

Because in Finland prospective subject teachers study their subjects outside departments of teacher education, the question of content knowledge concerns university studies in general. Since Shulman sees content and pedagogical knowledge as intertwined, he states that teacher education is the responsibility of the entire university [3]. Combining interdisciplinary courses and teacher education programs can improve students' understanding of the links between disciplines. In this way, CI is woven into the development of interdisciplinary studies in universities. Universities with teacher education programs can take into account the need to develop teachers' integrative knowledge by designing interdisciplinary study modules, although the difficulties and feasibility of using (inter)disciplinary knowledge directly for teaching purposes have been discussed above [25, 26].

A subject-based curriculum is the usual way of arranging schoolwork in Finland. When a change is proposed to the status quo, it must be well reasoned in order to make the objectives visible and understandable. Teacher education in Finland emphasizes pedagogical thinking [35], which requires teachers to understand the objectives of the curriculum. Shulman saw knowledge of educational purposes as being one of the most important categories of teachers' knowledge. As seen in the quotation above, the Finnish core curriculum briefly describes

the purpose of CI. Today, when CI is expected of schools, its purpose needs to be clearly acknowledged by teachers in order to enhance motivation to carry out the necessary reforms and plan integrated teaching in a goal-directed way. In teacher education, the purpose of CI has to be made explicit to inspire student teachers to develop their professional knowledge to include CI.

In subject teacher education programs in Finland, student teachers in different subjects study with instructors who are specialized in pedagogical content knowledge/didactics of certain subjects. Yet, in schools, teachers of all subjects form a community. It would be valuable for student teachers to gain experience in collaborating with student teachers in other subjects during the course of their university education. In some forms of CI, cross-subject collaboration is inevitable, and the experience with other teachers' subjects makes co-teaching and collaborative planning in CI more manageable. CI emphasizes the communal aspect of schoolwork. Bresler ([11], p. 36) describes it with a musical metaphor as "a shift from solo performance to a chamber work." Thus, co-teaching and collaborative planning have to be perceived from the perspective of CI. The outcome of experience in collaboration might not only be a better understanding of other subjects and their cultures, but also a better understanding of one's own disciplines and subjects and their presuppositions and commitments [36].

It is known that novice teachers in Finland are more interested in CI than are experienced teachers, but lack the courage and skills to implement it [33]. A teacher education program can be designed so that every student teacher has to take part in planning and implementing at least one integrated study module with other student teachers. Once the process is completed from beginning to end, the whole idea of CI is likely to be better comprehended. Because student teachers do not necessarily have any prior experience of CI, it would be difficult to expect them to apply it successfully in practice if it was not part of a teacher education program [37].

Perhaps the strongest challenge in developing teacher education from the perspective of CI is the strong tradition of subject-divided pedagogies and teachers' fixed positions as subject teachers. Another challenge from a teacher's perspective is created when all the "innovations," such as use of the latest technology, enhancing co-teaching and CI, are implemented at the same time [38]. In some visions the future teaching staff will consist of generalist and specialist teachers working together in new cooperation-based schools [33]. A good starting point is not only developing subject pedagogy, but also developing a pedagogy for CI. There is a long tradition of general and subject didactics in Finland, but there is no such a thing as a didactics of CI, although some experiments have been carried out in departments of teacher education [33, 39]. Here we can see the missing paradigm of today: the development of *integrative pedagogical knowledge* that would include at a minimum (1) knowledge of CI as a possibility for constructing a curriculum, (2) knowledge of concepts bridging different subjects, (3) knowledge of the purposes of CI, and (4) knowledge of collaborative teaching by subject teachers. Today, when the new Finnish core curriculum is requiring every school to implement CI, there is reason to research and teach it systematically in departments of teacher education.

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Subject matter specific curriculum integration: a quantitative study of finnish student teachers' integrative content knowledge

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ABSTRACT

Curriculum integration has recently stirred growing interest in educational discourses. New Finnish core curricula for basic education and for general upper secondary schools encourage and even obligate schools to integrate the curriculum. Integration has been deemed to be important, as the boundaries between school subjects have remained unnecessarily rigid. Integration is needed to construct a coherent structure for educational knowledge allowing for the study of broad-ranging topics crossing the subject boundaries. This paper is a piece of quantitative research based on a questionnaire completed by Finnish student teachers (N = 243) studying to teach a range of subjects in secondary schools (age groups 13–18). The questionnaire explored student teachers' readiness to generate integrative topics between subjects. Variables such as teaching experience or expertise in several subjects did not correlate with the readiness and the subject matter was found to be the main correlating variable. The results outlined in this paper indicate that subject specific differences exist in the potentiality of subjects to be integrated.

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Curriculum integration; subject teaching; pedagogical content knowledge; subject didactics

Introduction

Integration of the school curriculum has been an enduring topic in school development and education, and it has again received widespread international attention (see McPhail 2019). Generally, curriculum integration (CI) means bridge building between different school subjects or building an interdisciplinary curriculum with the objective of making learning more holistic and/or to increase curricular coherence. In the latest (2016) Finnish core curriculum for basic education (age groups 7–15) CI was made a compulsory part of curriculum enactment. The curriculum introduced multidisciplinary learning modules as a new element that integrates perspectives from school subjects (Finnish National Agency of Education 2016). Further, the new core curriculum for general upper secondary schools (age groups 16–18) encourages schools to design courses that integrate content from a range of subjects (Finnish National Agency of Education 2019).

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At the same time, Finnish curricula are relatively subject divided in international comparison (Dussel 2020). Thus, the Finnish curricula are simultaneously strongly differentiated according to subject boundaries, and they address the need to integrate the subjects. This dichotomy reflects the long debate in Finnish curriculum development whether the curricula should be more subject oriented or integrated (Vitikka, Krokfors, and Rikabi 2016).

This paper is a study of Finnish student teachers' views on the potentiality of integrating the content of various school subjects. With multidisciplinary learning modules and integrated courses in mind, it is important to know if some subjects are more open to integration than others are and if certain subjects have more potential for being integrated with some subjects rather than others. Previous research has given cause to search for subject-specific differences (McPhail 2018). The research question for this study is:

- What content-specific differences do student teachers identify in the suitability of subjects to be integrated with other subjects?

The content of school subjects can be divided into topics. Many subjects share topics that can serve as integrative bridges allowing cognitive advancement for students (McPhail 2018). For example, technology is a topic that can be approached differently from the perspectives of the natural sciences, social studies or crafts. If cognitive advancement is expected, it would be hard to imagine how integration of various subjects could take place without some shared topic, which can be conceptual, contextual, or problem-based (Nikitina 2006). The research question here has been answered by studying student teachers' perceptions of topics connecting various school subjects.

Theoretically, CI is commonly presented as a continuum with isolated subjects at one end, and complete abandonment of subject boundaries at the other end. In between, several forms of collaboration between subjects can be found (Gresnigt et al. 2014). It is not necessary to see CI and school subjects as opposites. A subject-based curriculum both differentiates and integrates knowledge (Niemelä 2021). First, subjects are formed by drawing subject boundaries that differentiate one field of knowledge from others. This enables integrating the content of a subject within its boundaries. However, topics such as global pandemics or climate change remain shared between subjects. To enhance the study of wide-ranging topics, integration between subjects is needed, as well as enhancing the coherency of the curriculum as a whole and supporting the cognitive advancement across subject boundaries.

Most research on CI has focused on integrative projects searching for suitable pedagogical alternatives (McPhail 2018). The role of content in CI has received only marginal attention. Maton and Howard (2018) point to the knowledge blindness that has largely framed the research on CI. To address the lack of research on integrative knowledge in the framework of subject-based curriculum, this study developed a novel quantitative approach to investigate CI. This paper provides an overview of the integrative potential of wide range of subjects present in the core curricula of Finnish secondary schools. In general, the use of quantitative methodology in researching CI has been rare. As the methodological choices always allow specific findings (Shulman 2004), the focus on qualitative research has steered the attention of the studies to certain direction.

In the Finnish system, pupils in age groups 7 to 12 are taught by class teachers, who are teaching the majority of the subjects. In turn, age groups 13 to 18 are taught by subject teachers specialised in one or a few subjects. The focus of this study is on student teachers preparing to become subject teachers. Studies have shown that CI provides subject teachers with specific challenges (McPhail 2019; Niemelä and Tirri 2018). Researching student teachers provides a pre-service viewpoint on CI that will be valuable in teacher education. Further, this approach unfolds the views of future teachers educated at university following the curriculum reforms that placed new emphasis on CI. In addition, this study serves as an explorative pilot that can be further developed and expanded to investigate in-service teachers.

Integrating subject matter

Many theories of teaching acknowledge teachers' content knowledge as the foundation for successful teaching (see Gitomer and Zisk 2015). Two widely referred theories underline the role of content knowledge for professional subject teachers: Lee Shulman's (1987) theory of pedagogical content knowledge and Continental European subject didactics (Kansanen and Meri 1999). However, the function of teachers' content knowledge has been overlooked in the recent research into CI that has focused primarily on students' learning and the role of the teacher has mostly been seen as a facilitator of learning (McPhail 2019).

A common principle for these two theories is that teachers' subject matter knowledge is essential for successful teaching, but not sufficient in itself without pedagogical knowledge. This is the basic idea shared by both theories (Kansanen 2009). Having enough content knowledge enables flexible teaching with various groups of students and development of topic-specific pedagogical practices such as examples, metaphors, analogies, exercises, and activities. With Shulman's (1987) conceptualisation, successful teaching cannot be based solely on general pedagogical knowledge nor on content knowledge of subject matter. They need to be synthesised as pedagogical content knowledge. In turn, the core concept for subject didactics is the didactic relationship. It addresses how a teacher relates to the relationship between the student and the content. The latter relationship is manifested as studying. Thus, the didactic relationship refers to the diverse ways how the teacher steers the studying process, i.e. the students' relation to the content (Kansanen and Meri 1999).

Shulman's (1987) concept of pedagogical content knowledge is composed of seven major categories of a teacher's knowledge: 1) general pedagogical knowledge, 2) knowledge of learners, 3) knowledge of educational contexts, 4) knowledge of educational ends, purposes and values, 5) content knowledge, 6) curriculum knowledge, and 7) pedagogical content knowledge (see Ball, Thames, and Phelps 2008). Niemelä and Tirri (2018) expanded Shulman's conceptualisation to study CI and developed the concept of a teacher's integrative pedagogical knowledge to study the knowledge requirements CI brings for teachers. Here, the focus is on integrative content knowledge, which is a part of integrative pedagogical knowledge and refers to teacher's knowledge of the topics suitable for integration in various subjects.

CI is challenging for subject teachers because they have specialised in one or a few subjects. If a teacher does not have adequate content knowledge of the subjects to be integrated, teaching will be based on everyday knowledge and good quality pedagogy is

unlikely to result. Therefore, student teachers' views of integrative topics was chosen as the area of interest for this study. However, integration of various subjects also requires many other aspects from teachers, such as collaboration skills, comprehensive understanding of the curriculum and awareness of the purpose of CI (Niemelä and Tirri 2018).

Further, the content of subjects consists of divergent forms of knowledge. Bernstein (2000) has divided educational knowledge into hierarchical and horizontal forms. The hierarchical form refers to the form of knowledge that builds cumulatively. To acquire hierarchical knowledge, it is necessary to begin from the elementary elements for understanding the higher levels. For example, one needs to know the concept of mass in physics before understanding gravitation. Hierarchical knowledge has a rigid structure and it aims at making generalisations. This form of knowledge is typical in the natural sciences. In turn, horizontal knowledge includes several specialised parallel languages. Learning a piece of a horizontal language does not presuppose deep preliminary knowledge. For example, one can understand the meaning of the fall of the Berlin Wall in history without deep knowledge of the Franco-Prussian War. The horizontal knowledge does not advance cumulatively, but via expansion.

Data and methods

A sample of the views of 243 student teachers studying in subject teacher education programmes at the University of Helsinki was collected twice, in February 2019 and February 2020 after a general lecture on CI. Participation in the study was voluntary and all participants remained anonymous. The study was not part of the official teacher education programme and it did not have an effect on students' academic success. According to the guidelines of the ethical committee of University of Helsinki, research design used in this study did not require an approval from the committee.

Scheduling the data collection after the lecture ensured that all respondents were aware of the meaning of CI. Each student teacher had studied certain disciplines as a major subject and then entered a subject teacher education programme to earn the formal teaching qualification for the major subject and for possible minor subjects (for an explanation of teacher education in Finland see e.g. Lavonen 2018). As 95% of the participating student teachers were in at least their fourth year of studying at university, they could be considered to be specialists well aware of the content of the subjects to be taught. Saloviita (2019) found that in general, Finnish student teachers in subject teacher education programmes are satisfied with the level of content knowledge for teaching that they achieved at university.

The major subjects of the participants are listed in Table 1. Some subjects taught at Finnish schools are missing, because it was not possible to study all the subjects as majors at the University of Helsinki. Some subjects, such as health education and ethics, are not usually major subjects. Furthermore, crafts and home economics have their own programmes and their student teachers do not participate in the general lectures. Some participants reported having information technology as a subject to be taught, but the study included only subjects that are mentioned in the two national curricula.

A questionnaire was designed to collect the data for this study. First, in addition to other background variables, the respondents selected the major and possible minor subjects they will teach. Then, they were asked to select how easy or difficult it was to

Table 1. Student teachers' readiness to generate integrative topics: divided by major subjects.

Major subject	*n*	M (SD)
Geography	7	3.4 (0.4)
History	13	3.2 (0.5)
Biology	12	3.1 (0.6)
Religion	34	3.0 (0.4)
Swedish	10	2.9 (0.4)
English	27	2.8 (0.3)
Chemistry	12	2.8 (0.4)
Other foreign languages	35	2.8 (0.6)
Mother tongue and literature	34	2.8 (0.4)
Physics	11	2.7 (0.5)
Mathematics	42	2.5 (0.5)
Total	243[a]	2.8 (0.5)

[a]Includes also a small number of psychology, philosophy, social studies and visual arts majors, which were deleted from the list for guaranteeing anonymity.

come up with topics that integrated their major subject with each of the 21 other subjects. The questionnaire comprised 22 subject-specific items on a four-point Likert scale (1 = 'Very difficult to generate', 2 = 'Difficult . . . ', 3 = 'Easy . . . ', 4 = 'Very easy . . . '). The item concerning students' own major subject was omitted in each case. The result was conceptualised as student teachers' readiness to generate integrative topics. It refers to how easy or difficult student teachers perceive it is to generate integrative topics between subjects. In this way, student teachers approximated the integrative content shared by the subjects.

Statistical analysis was undertaken in three stages. In the first stage, means and standard deviations were calculated for each subject. First, student teachers were placed in separate subject groups according to their majors (Table 1). Then, student teachers evaluated the integrative potential of subjects other than their major (Table 2). In addition, subjects were compared pairwise to reveal more specifically how easy or difficult it is to generate topics integrating certain subjects (Table 3). In the second stage, one-way analysis of variance was used to investigate the correlations of the background variables with student teachers' readiness to generate integrative topics. In the last stage, correlations between subjects were studied using exploratory factor analysis (Table 4).

Results

In the first stage, the integrative potential of subjects was studied from two directions: 1) student teachers' views on the integrative potential of other than their major subject, and 2) student teachers' views on the integrative potential of their major subject.

Table 1 mentions Swedish as a subject. In Table 2 it is referred to as the 'second national language'. Table 2 lists the means of how easy or difficult student teachers saw it as being to generate integrative topics between their major subjects with all other subjects.

Table 2. Student teachers' readiness to develop integrative topics between their major subjects with other subjects.

Non-major subject	*n*	*M* (SD)
History	230	3.2 (0.9)
Social studies	242	3.2 (0.8)
Geography	236	3.2 (0.7)
Visual arts	242	3.1 (0.8)
Mother tongue and literature	209	3.1 (0.8)
English	216	3.0 (0.7)
Home economics	243	3.0 (0.9)
Music	243	2.9 (0.9)
Health education	243	2.9 (0.8)
Ethics	243	2.9 (1.0)
Biology	231	2.8 (0.8)
Philosophy	241	2.8 (0.9)
Second national language	233	2.8 (0.9)
Religion	209	2.7 (0.9)
Other foreign languages	208	2.7 (0.9)
Psychology	241	2.6 (0.9)
Physics	232	2.6 (1.0)
Physical education	243	2.6 (0.9)
Chemistry	231	2.5 (1.0)
Crafts	243	2.5 (0.9)
Guidance counselling	243	2.4 (0.9)
Mathematics	201	2.4 (1.0)

To continue the analysis, a sum variable was formed by counting the mean of subject specific items for each respondent. The new variable shows the mean of 21 items measuring student teachers' readiness to generate integrative topics between their major subject and all other subjects. Thus, each respondent received a mean describing their general readiness to generate integrative topics.

Then, applying the sum variable, subject teachers' readiness to generate integrative topics were grouped according to their majors and listed in Table 1. The statistical significances of the differences between the means are discussed in the next section. Especially noteworthy for the analysis below is the low general readiness of students with mathematics majors and the high general readiness of students with geography, history, biology and religion majors.

Table 3 unpacks the results presented in Table 1. It shows subject-wise comparisons of student teachers' readiness to generate integrative topics connecting their majors with each other subject. Table 3 acts as a preliminary map revealing potential grounds for integrative bridges between specific subjects.

Subjects to be taught correlate strongly with student teachers' readiness to integrate

One-way analysis of variation was used to study the correlation of general readiness to integrate with background variables: 1) age, 2) gender, 3) teaching experience, 4) number of subjects to be taught, 5) study year, 6) major subject, and 7) second subject to be taught. Before conducting the analysis, the normal distribution of the sum variable was investigated. The Kolmogorov-Smirnov test ($p = .003$) disproved the hypothesis of the normal distribution. However, when the skewness and kurtosis were examined in more

Table 3. Student teachers' readiness to integrate their major subjects with each other subject: M (SD).

Major subjects											
Subjects to be integrated with	Geography	History	Biology	Religion	Swedish	English	Chemistry	Other foreign languages	Mother tongue and literature	Physics	Mathematics
History	3.7 (0.5)	–	3.2 (0.7)	3.8 (0.5)	3.2 (0.6)	3.3 (0.7)	3.3 (0.7)	3.3 (0.8)	3.6 (0.6)	3.4 (0.7)	2.2 (0.8)
Social studies	3.7 (0.5)	4.0 (0.0)	3.2 (0.7)	3.6 (0.5)	3.3 (0.7)	3.2 (0.6)	2.9 (0.7)	3.1 (0.9)	3.4 (0.7)	2.9 (1.0)	2.6 (0.8)
Geography	–	3.6 (0.7)	3.7 (0.7)	3.4 (0.7)	3.2 (0.6)	3.0 (0.7)	3.2 (0.8)	3.3 (0.7)	2.9 (0.6)	3.4 (0.7)	3.0 (0.6)
Visual arts	3.6 (0.5)	3.5 (0.5)	3.2 (0.6)	3.7 (0.5)	3.3 (0.7)	2.6 (0.8)	2.9 (0.8)	3.1 (0.8)	3.3 (0.7)	2.1 (0.8)	3.1 (0.7)
Mother tongue and literature	3.6 (0.5)	3.9 (0.4)	3.3 (0.8)	3.3 (0.6)	3.4 (0.5)	3.5 (0.6)	3.1 (0.7)	3.1 (0.7)	–	3.0 (0.8)	2.2 (0.8)
English	3.3 (0.5)	3.6 (0.7)	3.3 (0.7)	3.0 (0.7)	3.6 (0.5)	–	2.9 (0.7)	3.3 (0.6)	3.1 (0.5)	3.1 (0.7)	2.4 (0.8)
Home economics	3.4 (1.1)	2.8 (0.8)	3.2 (0.7)	3.1 (1.0)	3.5 (0.5)	2.9 (0.8)	3.8 (0.4)	3.3 (0.8)	2.5 (0.8)	2.4 (1.1)	2.8 (0.8)
Music	3.4 (0.8)	3.2 (0.6)	2.3 (0.8)	3.4 (0.6)	3.5 (0.7)	3.1 (0.8)	1.8 (0.8)	3.2 (0.8)	2.8 (0.9)	3.3 (0.6)	2.5 (0.8)
Health education	3.6 (0.8)	2.7 (0.9)	3.8 (0.6)	2.9 (0.7)	2.7 (0.7)	2.9 (0.7)	3.3 (0.5)	2.7 (0.9)	3.0 (0.6)	2.7 (0.9)	2.5 (0.8)
Ethics	3.3 (1.0)	3.9 (0.4)	2.8 (0.8)	3.8 (0.4)	2.8 (0.9)	3.0 (0.6)	1.8 (0.7)	2.8 (0.9)	3.2 (0.4)	2.0 (0.8)	1.8 (0.6)
Biology	3.9 (0.4)	2.7 (0.9)	–	2.8 (0.8)	2.6 (0.7)	2.7 (0.7)	3.8 (0.4)	2.4 (0.8)	2.6 (0.6)	3.1 (0.7)	3.0 (0.6)
Philosophy	3.1 (0.7)	3.5 (0.7)	2.7 (1.1)	3.6 (0.5)	2.4 (0.8)	2.9 (0.8)	2.6 (1.0)	2.6 (1.0)	3.1 (0.7)	2.2 (0.9)	2.2 (0.9)
Second national language	2.7 (0.7)	3.5 (0.5)	3.1 (0.8)	2.7 (0.9)	–	3.3 (0.7)	2.6 (0.7)	3.1 (0.7)	3.1 (0.6)	2.0 (1.1)	2.1 (0.8)
Religion	3.4 (0.8)	3.9 (0.4)	2.5 (0.7)	–	2.9 (0.9)	3.0 (0.6)	1.8 (0.9)	3.0 (0.8)	3.3 (0.4)	2.1 (1.0)	1.8 (0.7)
Other foreign languages	3.0 (0.6)	3.1 (1.0)	2.8 (0.9)	2.6 (0.9)	3.5 (0.5)	3.4 (0.6)	2.2 (0.6)	–	3.1 (0.6)	2.1 (1.1)	2.1 (0.8)
Psychology	3.0 (0.6)	2.9 (0.9)	3.2 (0.7)	3.3 (0.6)	2.5 (0.9)	2.6 (0.6)	2.0 (1.0)	2.1 (0.9)	3.0 (0.7)	1.7 (0.5)	2.1 (0.8)
Physics	3.6 (0.5)	2.9 (0.9)	3.3 (0.7)	1.8 (0.6)	2.0 (0.5)	2.3 (0.5)	3.7 (0.5)	2.1 (0.8)	1.9 (0.8)	–	3.6 (0.5)
Physical education	3.6 (0.5)	2.5 (1.1)	3.0 (1.0)	2.3 (0.9)	3.1 (0.9)	2.6 (0.8)	2.2 (0.7)	2.8 (0.9)	2.2 (0.9)	2.7 (0.8)	2.6 (0.9)
Chemistry	3.4 (0.8)	2.6 (1.0)	3.7 (0.7)	1.7 (0.6)	2.0 (0.5)	2.3 (0.6)	–	2.1 (0.8)	1.9 (0.8)	3.7 (0.5)	3.5 (0.7)
Crafts	2.7 (0.8)	2.9 (1.0)	2.7 (1.0)	2.8 (0.9)	2.8 (0.9)	2.1 (0.7)	2.6 (1.0)	2.4 (0.9)	2.1 (0.9)	2.6 (0.8)	2.6 (0.9)
Guidance counselling	3.0 (0.6)	2.5 (1.0)	2.8 (0.9)	2.4 (0.9)	2.5 (0.7)	2.5 (0.6)	2.9 (0.7)	2.2 (0.8)	2.6 (0.9)	2.6 (1.1)	1.9 (0.8)
Mathematics	3.1 (0.7)	2.6 (0.8)	3.2 (0.8)	1.9 (0.8)	2.3 (0.5)	2.3 (0.7)	3.8 (0.5)	2.1 (0.9)	1.8 (0.7)	3.9 (0.3)	–
n	7	13	12	34	10	27	12	35	34	11	42

Table 4. Factor loadings and extraction communalities.

	1 Human sciences	2 Mathematics and natural sciences	3 Languages	4 Artistic and practical subjects	h^2
Ethics	**.913**	−.163	.021	−.041	.833
Psychology	**.820**	.177	−.064	−.113	.557
Philosophy	**.799**	.071	−.073	.000	.586
Social studies	**.726**	.024	−.057	.119	.588
History	**.709**	−.127	.025	.128	.634
Religion	**.629**	−.141	.196	−.052	.548
Health education	**.431**	.382	.071	.067	.443
Chemistry	−.111	**.857**	−.046	.010	.750
Physics	−.110	**.856**	−.100	.025	.762
Mathematics	−.061	**.710**	.136	−.018	.520
Biology	.268	**.637**	−.093	.058	.505
Guidance counselling	.319	**.367**	.217	−.012	.369
Second national language	−.099	−.070	**.885**	.063	.727
English	−0.28	−.011	**.812**	.080	.686
Other foreign languages	−.039	.028	**.808**	−.016	.615
Mother tongue and literature	.336	.012	**.610**	−.142	.616
Home economics	−.138	.045	.100	**.742**	.544
Crafts	.035	.144	−.077	**.671**	.542
Visual arts	.300	−.127	−.161	**.636**	.538
Physical education	−.146	.206	.089	**.630**	.513
Music	.248	−.214	.016	**.544**	.452
Geography	.135	.136	.154	**.425**	.430

detail, they did not have values more than 3.29 times their standard error, which allows for the null hypothesis of sufficient normal distribution with medium-sized samples to be sustained (Kim 2013). Therefore, parametric analysis methods were used.

The analysis revealed that teaching experience or the number of subjects to be taught did not correlate statistically significantly with the readiness to generate integrative topics. The result is counter-intuitive, as one could expect more teaching experience to provide more ideas about shared topics. Similarly, expertise on a wider group of subjects would be a reason to expect one to see more linkages between them. Neither study year nor gender had a statistically significant correlation. However, major subject, second subject and age did have statistically significant correlations. Next, analysis of these three variables is examined more closely.

First, one-way analysis of variance was used to examine subject-wise differences in readiness to integrate students' *major subject* with other subjects. Students perceived significant differences between subjects ($F(10, 226) = 4.416$, $p < .001$, $\eta^2 = .163$). According to Cohen's (1988) parameters, the effect size was found to be large, thus showing that readiness to generate integrative topics correlates strongly with the major subjects. Equality of variances was assured with Levene's test ($p = .545$). Then, Bonferroni's post hoc test was used to study the differences in variance between subject groups in more detail. It showed that statistically significant differences can be found between student teachers majoring in mathematics and four other groups, which are student teachers majoring in geography ($p = .001$), biology ($p = .015$), history ($p < .001$) and religion ($p = .003$).

Second, student teachers' readiness to integrate was studied from the perspective of their *second subject* to be taught. One-way analysis of variance showed that also the second subject correlated in a statistically significant way with the readiness to generate integrative topics ($F(16, 145) = 1.779$, $p < .039$, $\eta^2 = .164$), however post hoc tests did not reveal any statistically significant subject specific differences. Again, the effect size was large.

Third, one-way analysis of variance between *age groups* shows that there are significant differences ($F(3, 238) = 4.402$, $p = .005$, $\eta^2 = .053$). However, when the composition of the age groups was studied, it revealed that the division of major subjects between age groups is not equal. Younger age groups include more mathematics student teachers who were previously revealed as being a group having a significant effect on the results. When mathematics student teachers were eliminated from the analysis, the result was no longer statistically significant. Therefore, it can be assumed that in this study, the differences in readiness to integrate between age groups were largely due to their different major subjects.

Four subject groups

Finally, an exploratory factor analysis was conducted to study how the integrative potential of various subjects is correlated according to the student teachers. The latent factor dimensions reveal if student teachers' readiness to integrate their major subject with some subject correlates with readiness to integrate the major subject with other subjects i.e. if there are groups of subjects that integrate in the same direction. For example, when chemistry is integrated with another subject, the result enables it to be reasoned that there are many topics touching physics as well. Overall, the factors describe the groups of subjects sharing integrative topics. The factor model creates a generalised picture of the results presented in Table 3.

The exploratory factor analysis included all 22 subject items used in the survey. Communalities visible in Table 4 were found to be above .3 for all items. The Kaiser-Meyer-Olkin test result was .856 and the result of Bartlett's test of sphericity was that it was significant ($p < .001$). Therefore, the factor matrix was proved to be acceptable. The analysis was conducted with Principal Axis Factoring extraction, because not all items were normally distributed. Promax rotation was used to allow for correlations between groups of subjects. The analysis revealed four underlying factors exceeding Eigenvalue 1, explaining 65% of the variance cumulatively. The factors and their loadings are presented in Table 4. All four factors had high values for Cronbach's Alpha presented in Table 5. No significant increase in the Alpha values would have been achieved by dropping some items, nor it would have been theoretically sound to leave out some subjects. Table 5 also shows the correlations between factors.

Table 5. Alpha loadings and correlations among the factors.

Factors	α	1	2	3	4
1 Human sciences	.90	–			
2 Mathematics and natural sciences	.86	.02	–		
3 Languages	.90	.55	.08	–	
4 Artistic and practical subjects	.82	.53	.43	.38	–

The four factors were labelled as 1) Human sciences, 2) Mathematics and natural sciences, 3) Languages, and 4) Artistic and practical subjects. The four-factor model corresponds well with the common way to group subjects in the Finnish curricula (Saloviita 2019). This result confirms the categorisation as having internal rationale or reflects how students are well socialised to think through these categories.

Three subjects require distinctive attention: heath education, guidance counselling, and geography. Health education loaded relatively equally to two factors and guidance counselling to three factors. These two subjects do not fall easily into any subject group. Health education is an integrative subject sharing perspectives from human and natural sciences. In the factor model, health education had loadings for both dimensions. In turn, guidance counselling is a special type of subject with a focus on general study skills and career planning. The role of geography will be discussed in the next section.

Discussion

The main conclusion of this paper is that according to the student teachers, CI is subject matter specific. The variance of student teachers' readiness to generate integrative topics did not correlate in a statistically significant way with any variables other than with the subjects the student teachers were going to teach. Therefore, when curriculum is integrated, it is essential to pay attention to what content is being integrated. The conclusion corresponds well with the frameworks of pedagogical content knowledge and subject didactics that point to the important role of content knowledge in teaching.

The most obvious subject specific result indicates that mathematics is a challenging subject from the perspective of CI. However, it is noteworthy to acknowledge that low perceived integrative potential does not mean that mathematics would in any sense be worse than other subjects. Instead, the results show that in the case of mathematics, particular attention must be paid to the subjects it is integrated with. The factor analysis grouped mathematics with the natural sciences with which mathematics shares many boundary crossing opportunities.

Table 5 shows that mathematics and the natural sciences do not really correlate with any other factor except with artistic and practical subjects. This result gives support for integration within the so-called STEAM subjects (Science, Technology, Engineering, Art, and Mathematics), which has recently been a popular grouping of subjects (Perignat and Katz-Buonincontro 2019). However, as Table 3 shows, student teachers undertaking biology, chemistry, and physics majors located many shared topics with history. Although students undertaking history majors did not see these connections as strongly, adding history to a STEAM collaboration could provide an opportunity to overcome the traditional dichotomy between the human sciences and the natural sciences.

Another subject that needs to be discussed is geography, which is the only subject that had positive loadings with all factors. Thus, as also Table 3 shows, geography was found to be a subject that has high potential to be integrated with almost all other subjects. This can explain geography's unexpected place in the factor model. These results provide a reason to consider if geography as a subject could serve a special integrative role. Geography, which includes perspectives from natural and cultural geography, has been traditionally close to biology in Finnish schools (Tani 2014). However, in the factor model, biology is grouped with mathematics and the natural sciences. As shown in Table 3,

student teachers undertaking biology majors located as many shared topics with chemistry as with geography. Thus, it is worth asking if biology should be more directly connected with chemistry in addition to its traditional partnership with geography.

Overall, the variation between the subjects can be explained by: 1) students' socialisation to different disciplinary cultures, and 2) differences in the forms of knowledge. Ylijoki (2000) has studied the territories of the academic tribes in Finnish university life. Students can be seen as novices in the academic disciplines internalising what are seen as the vices and virtues in the tribe. The tribal culture may direct the students to see appropriate opportunities for integration with some subjects rather than others. In addition, student teachers are socialised into the various teaching traditions, which set their boundary conditions to integrative collaboration (Sund, Gericke, and Bladh 2020).

Further, the variations between the subjects can also be explained with the differences in the forms of knowledge present in the subject matter. The factor model adheres well with Bernstein's (2000) division between hierarchical and horizontal forms of knowledge. The factor titled 'mathematics and natural sciences' collects disciplines organised in accordance with the hierarchical form of knowledge. Bernstein breaks horizontal knowledge further into two sub-forms: knowledge with strong and weak grammars. Knowledge with a strong grammar refers to fields able to produce precise descriptions and formal modelling. In the factor model, the 'languages' group includes subjects following the strongest grammar, 'human sciences' grammar with medium strength, and 'artistic and practical subjects' the weakest grammar. The weaker the grammar is, the more context dependent and subjective the form of knowledge is. A tendency in the results is that subjects with a horizontal knowledge structure and especially with medium or weak grammar, such as geography, history, visual arts and home economics, are perceived as having high integrative potential, although exceptions can also be seen. In some cases, the context specificity of a weak grammar subject, such as crafts and physical education, may make the content less relevant outside its own sphere, thus limiting its integrative potential.

This research focused on investigating student teachers' integrative content knowledge. It is important to acknowledge the difference between disciplinary knowledge and teachers' content knowledge for teaching (Ball, Thames, and Phelps 2008). It is beyond the scope of this study to examine what potential for integration the subjects might have in themselves as abstract entities. For teaching, how the teachers experience the subjects and their potential for integration is essential, although student teachers' assumptions about subjects' integrative potential can change after they have implemented integrative teaching (Kallunki, Karppinen, and Komulainen 2017).

As noted above, researching CI using quantitative methods has been rare. Therefore, certain perspectives of CI have remain understudied, as different methodological choices allow different sides of a phenomenon to be examined (Shulman 2004). In this study, the methodological approach allowed for an overview of integrative potential to be established of a wide range of subjects in the two Finnish secondary core curricula. What this study gains in its breadth, it loses in depth. The results remain indicative, and they need to be reflected on with caution. However, what the results indicate is worth noting, as this study has grasped the whole subject structure of Finnish secondary schools and the effect sizes of the results are large.

Qualitative studies have focused in more detail on attempts to integrate a few subjects (see e.g. Kallunki, Karppinen, and Komulainen 2017). They can reveal special characteristics of what certain subjects bring to integration and what potential specific pedagogical solutions have. The results of this study can be used to design further studies to test if certain subjects have more potential to be integrated with each other than with some other subjects. One way to bring this study further forward would be to investigate what topics the subjects are sharing. Starr and Krajcik (1990) have proposed the creation of concept maps as instruments for differentiating and integrating conceptual content knowledge and arranging it as a hierarchic curricular structure. In addition, mapping the topics shared by subjects could be used as a tool in teacher education and in curriculum design for integrating subject matter both within and between the subjects.

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III

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Crossing curricular boundaries for powerful knowledge

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This paper makes a theoretical contribution to the discussion of powerful knowledge in education. The major claim is that curriculum integration can structure knowledge for a coherent curriculum and thus, support the idea of powerful knowledge. The mainstream understanding of curriculum integration promotes it as a pedagogical arrangement and views school subjects as being guilty of fragmenting students' experience. Leaning on empirical evidence, this paper argues that the question of integration cannot be left to teachers and students alone; rather, it is crucial to design a coherent written curriculum that supports the teaching-studying-learning process with an appropriately differentiated and integrated structure for school subjects. Alternatives for subject design and knowledge-based curriculum integration with the potential for developing powerful knowledge are presented.

Keywords: powerful knowledge; curriculum integration; curriculum coherence; curriculum design

Introduction

The objective of this paper is to contribute to the development of the concept of powerful knowledge in schooling, mainly advocated by Michael Young, Johan Muller and colleagues in the school of *social realism* during the last decade, by showing that powerful knowledge is compatible with the aims of curriculum integration. Young (2013) has stated that curriculum theory is in crisis because the role of knowledge has lost its place in education. The intention of the recent discussion has been to bring knowledge back into curriculum studies.

According to Young and Muller (2013), the notion of powerful knowledge requires maintaining a sense of boundaries. Boundaries differentiate school knowledge and everyday knowledge and the various school subjects. However, boundary maintenance is deemed a precondition for boundary crossing (Young & Muller, 2010). Nonetheless, the discussion on powerful knowledge has focused on the question of boundary maintenance. What powerful boundary crossing in fact means has remained under-theorised. Therefore, this paper develops an understanding of curriculum integration that respects the boundaries of knowledge in education.

Young and Muller's approach to the idea of boundary crossing has been bipartite. They see boundary crossing as a valuable objective, although at the same time they criticise attempts to integrate curriculum (Young & Muller, 2010; Young, 2014).

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The contradiction stems from the way Young and Muller interpret the idea of integration, which reflects a mainstream understanding that emphasises the learning of future competences through integrated, inquiry-based pedagogies focusing on 'real world' problems that are not divided along the boundaries of school subjects. This interpretation is not surprising, as interdisciplinary curriculum has been used almost exclusively as a synonym for a learner-centred pedagogy (Grossman *et al.*, 2000) and curriculum integration has been identified as part of learner-centred curriculum ideology (Schiro, 2013).

According to Young and Muller (2010), this ideology blurs the boundaries between school and everyday knowledge as well as between school subjects. However, alternative ways to think about curriculum integration do exist (see Pring, 1971). In this paper, the current understanding of curriculum integration is reformulated by demonstrating how both maintaining and crossing the boundaries of school subjects is essential for an integrated curriculum. Integration within and between subjects is a deeply intertwined process. Both serve the objective of curricular coherence. The coherence within a subject depends on how it is supported by other subjects and coherence between subjects depends on how the subjects are constructed internally. While the paper is not the first to claim that boundary crossing is a crucial question for powerful knowledge, concrete propositions for curriculum design have been scarce. This paper adds to the discussion by making suggestions for *how* curricular boundaries can be drawn and crossed to support the development of powerful knowledge through a coherent curriculum design.

The argumentation of this paper takes the following main steps. First, Young and Muller's model of three educational scenarios is presented as background to the central discussion in the paper. Specific attention is paid to the different standpoints on disciplinarity included in the scenarios. Next, the concept of powerful knowledge is explained, first by describing how Young and Muller address boundary maintenance as its essential quality, then, by reflecting on the role of boundary crossing. Then, the paper demonstrates why boundary crossing should be considered especially at the level of the written curriculum. Finally, alternatives for curriculum design are offered. The paper has two main research questions: Why is boundary crossing important for powerful knowledge? How can the development of powerful knowledge be enhanced by drawing and crossing the boundaries of knowledge in school curriculum?

Educational scenarios for the future

Young and Muller (2010) have presented an ideal-type model of contrasting trends in education that has gained much attention recently. They have pinpointed three educational scenarios for the future: antagonism between two prevailing scenarios and one scenario emerging as a favourable mediating alternative for the future. The model is by no means the first time that scholars have proposed such an image of shifting educational paradigms. Oelkers (1994) noted that similar competing paradigms date back to the time of Locke and Rousseau, with Locke stressing education that focuses on external *influence* and Rousseau seeing education as *development* that stems from within an individual. The need to overcome the juxtaposition of such

knowledge-centred and learner-centred extremes was also raised by, for example, Dewey (1953).

The three educational scenarios can be portrayed by describing their relations to boundaries in education (Young & Muller, 2010). The first educational scenario functions based on rigid boundary maintenance, while the second one depends on boundary crossing leading to the diminishing of boundaries and the third relies on a vision of education maintaining the boundaries as a precondition for boundary crossing. Discussions have primarily concentrated on the boundary between school and everyday knowledge and the boundaries between school subjects. Bernstein (2000), who had a central influence on the social realism movement, has referred to the former boundary-making effort as framing and to the latter as the classification of educational knowledge. Next, the role of boundaries in the three educational scenarios is looked at in more detail.

Scenario 1: Under-socialised conception of knowledge

The first educational scenario stems from the under-socialised conception of knowledge (Young & Muller, 2010). The nature of knowledge is conceived as fixed and ahistorical and disciplinary boundaries are taken as a given. It is founded on a positivistic epistemology. Educational knowledge is deemed under-socialised because the origins and purpose of curricular knowledge is unquestioned. Behaviouristic learning theory exemplifies this scenario in educational science, while teacher-dominated pedagogics does so in the classroom.

Ideal-type models are generalisations and do not accurately depict historical developments, but they do serve as tools to grasp essential trends that can be simultaneously present, although at unequal strength. The first scenario best describes modern elite school systems that were dominant before the rise of mass public education and still exist alongside it (Young & Muller, 2010). The task of schooling is seen as preserving the established order, including the boundaries between social classes. The tracking of pupils along different paths in schooling amplifies the social reproductive function of education. Therefore, the main criticism of the first scenario is that it serves the interests of those in power.

Scenario 2: Over-socialised conception of knowledge

Young (2013) proclaims that curriculum theory is in crisis because the second scenario has gained hegemony, with curriculum theory mainly concentrating on issues of culture, power and identity, not on the content of education. Biesta (2014) has associated the second scenario with what he refers to as the 'learnification of educational discourse'. Young and Muller (2010) identify it as a development towards the end of the boundaries between school and everyday knowledge and between different fields of knowledge. In academia, various transdisciplinary aspirations express the same spirit. In schools, it is visible in the form of learner-dominated pedagogics that stress the individual experiences of a child. Boundaries between school subjects are treated as obstacles to good learning and are being replaced by themes, problems or phenomena to be explored. Knowledge as an objective of learning is being replaced

with the acquisition of generic skills. Common phrases associated with the second scenario include 'learning to learn' or '21st-century competences'.

Young and Muller (2010) claim that the major reason for diminishing boundaries is an over-socialised conception of knowledge stemming from a social constructivist paradigm in educational research associated with the broader framework of post-modernism. Young and Muller describe the constructivist notion of knowledge as 'discourses of voice'. In these discourses, the truthfulness of knowledge is judged according to the perspectives of different social groups. Primarily, knowledge is seen as a struggle for power. Young and Muller do not deny the importance of the analysis of power in curriculum studies, which was the focus of Young's (1971) earlier work, but they argue that making decisions on the content and objectives of education becomes problematic if such decisions are based on the opinions of various interest groups. Overall, it is not possible to talk about education without defining its content and objectives because education is about the purposeful study of certain content with the ambition that new generations will benefit from the work of preceding generations (Young, 2016).

Young and Muller's account of social constructivism runs the risk of being interpreted as building a strawman as an object of critique. As Hacking (1999) has shown, use of the label social constructivism is so common and diverse that it lacks clear definition. Therefore, it is beneficial to define more precisely just what sort of constructivism is problematic. In educational sciences, the term has mainly been used in two ways (McPhail, 2016). The first refers to social constructivism as an epistemological stance and the second as a theory of learning. Criticism has focused more on the first use of the term, which can be defined as the above-described epistemological relativism. In turn, social constructivism as a theory of learning resides on a stronger foundation if it is understood in such a way that 'social' addresses the interpersonal character of learning and 'constructivism' stresses that all learning is built upon earlier experiences (Schneider & Stern, 2010). However, the theory of learning must be put into context when discussing educational issues and not treated as learning in general, which is part of everyday human experience. Learning some educational content intentionally can be referred to as studying, which is a key element in the teaching-studying-learning process in schools (Kansanen, 2003).

Scenario 3: Powerful knowledge

The recent criticism of the second scenario and return to the question of knowledge in education has been labelled the 'knowledge turn' (Morgan *et al.*, 2019). The third scenario is an attempt to go beyond the dichotomy of the previous two scenarios by recognising both the value of specialised knowledge and the nature of knowledge as socially produced. It aims at boundary maintenance, which is conceived as a precondition for boundary crossing (Young & Muller, 2010). This is a typical interdisciplinary standpoint, one which Szostak (2007) presents as a third alternative to discipline-focused modernism and postmodern relativism. The concept of powerful knowledge has been introduced as an objective of education that is representative of the third scenario (Young & Muller, 2010, 2013; Muller & Young, 2019).

Priestley and Sinnema (2014) claim that Young and Muller have not paid enough attention to the difference between disciplinary knowledge and school subjects and that they are committed to maintaining the traditional structure of school subjects. Deng (2020) has criticised Young and Muller for separating questions regarding curriculum from those pertaining to pedagogy and for focusing too much on the curricular level, thereby dismissing questions about the meaning of education for the students. Further, Young and Muller's formulation of the third educational scenario has been criticised for not being described in enough detail (Alderson, 2019). It has been articulated mostly as a critique of the second scenario and as such, it has not always been easy to see the distinction between the first and the third scenario (Morgan *et al.*, 2019). Here, boundary crossing that is based on boundary maintenance is emphasised as a distinctive factor. The idea of powerful specialised knowledge is summarised in the next section. Thereafter, the paper develops the idea of powerful knowledge achieved through boundary crossing.

Powerful knowledge through boundary maintenance

Not all knowledge is equally powerful and suitable for educational purposes. Young and Muller (2013), Muller and Young (2019) distinguish between three types of knowledge—(1) everyday knowledge, (2) knowledge of the powerful and (3) powerful knowledge—as heuristic tools for understanding the meaning of knowledge in schooling. The social realist argument is that the power of powerful knowledge is founded on objective groundings in the criterion of truth in scientific inquiry. The 'social' in social realism means that powerful knowledge emerges from social conditions, although it cannot be reduced merely to discourses of voice. The 'realism' in social realism refers to the epistemological stance that objectivity of knowledge, although always incomplete, can be achieved when a community of specialists publicly judge its truthfulness. When access to powerful knowledge is obstructed, the content of education either rests on knowledge of the powerful or on everyday knowledge. Then, the criterion for selecting educational knowledge is formed in political struggle or by intuition (Young & Muller, 2013).

Young and Muller (2013) describe powerful knowledge as specialised knowledge and everyday knowledge as non-specialised knowledge. An intellectual division of labour makes the power of specialised knowledge possible. Not all specialised knowledge, though, is powerful if it is not systematic and fallible. Powerful knowledge is assessed systematically through shared criteria for scientific truth, however, with the assumption that the criteria and the truth achieved need to always be open for reconsideration. Refutation of systematic assessment and the possibility of error are usually the characteristics of knowledge of the powerful.

Specialisation supplies knowledge with the power to transcend particular contexts and to generalise or transfer the abstracted knowledge to various situations. Through specialisation, knowledge is not just a collection of facts; it is connected to a certain structure that provides the rationale for the facts. In natural sciences, this is achieved through laws that have broad explanatory power, while in the social sciences and humanities through an abstracted conceptual understanding of social and cultural

phenomena. Such abstracted knowledge allows for thinking beyond what is and imagining alternatives (Young & Muller, 2013; Muller & Young, 2019).

Children go to school to expand their worldview via access to knowledge that cannot be acquired in their own communities (Young, 2016). Knowledge can be called powerful when it provides students with opportunities to go beyond their everyday knowledge (Young & Muller, 2013). Certain knowledge can be defined as important for each citizen and the purpose of education is to provide all people with the opportunity to develop a basic understanding of nature, society, art and so forth and such basic skills as literacy, critical reasoning and ethical reflection. The issue of powerful knowledge is essentially about social justice. Since children from different socio-economic backgrounds do not come to schools with equal symbolic preparedness for specialised knowledge, the lack of powerful knowledge in schools hurts especially those students who begin with relatively little cultural capital (Young, 2016).

Powerful knowledge through boundary crossing

Powerful knowledge is achieved through boundary maintenance between specialised knowledge, everyday knowledge and knowledge of the powerful. At the same time, knowledge integration achieved via boundary crossing is relevant for achieving powerful knowledge. When its objective is to achieve curricular coherence, integration of knowledge does not necessarily mean the loss of boundaries. The argument is made that boundary crossing is relevant for achieving powerful knowledge and the section explores what coherence would mean as an objective of boundary crossing and the kinds of challenges that educators have encountered when crossing the knowledge boundaries separating school subjects.

Purpose of boundary crossing

Numerous claims advocating the crossing the boundaries of educational knowledge have been presented since the early days of schooling. Here, two arguments claiming that boundary crossing can result in powerful knowledge are examined. The arguments are 1) epistemological and 2) educational.

Above, specialisation was described as a tool for assuring the truthfulness of knowledge. However, the interconnectedness, contextuality and complexity of phenomena occurring in nature and society require attention as well. According to Carr (2007), the majority of current theories on knowledge acknowledge that knowledge claims must be examined rather as an interconnected body than individually. This forms the basis for the epistemological argument for boundary crossing.

A contemporary example is that of climate change. Another example could be built around any other current developmental goal of the United Nations (2015). To equip students with the tools to take social action towards slowing global warming, new generations first need to know what climate change means, what the mechanisms are behind it and that it is true. It is an example of a broad phenomenon that requires the integration of various fields of knowledge to be powerfully understood (see Bhaskar, 2010). In this case, the fields of knowledge would include, for instance, physics to explain the greenhouse effect, biology to explain how animals produce

methane or how plants bind carbon dioxide, geography to explain the effects of rising temperature on vegetation zones, economics to explain the change in energy prices, history to understand the era of industrialisation, social studies to understand the role of international politics or social movements and so on. Below, several alternatives are proposed for how the connections between disciplinary perspectives can be integrated into a single curriculum.

The second main argument for boundary crossing concerns the educative function of knowledge. Carr (2007) distinguishes between education and schooling, with the former being the purpose for the latter. For Carr, an educated person has achieved a holistic worldview, in contrast to learning instrumental and fragmented knowledge or skills. In continental Europe, such a claim has been attached to the notion of Bildung. For Humboldt (2000), Bildung or the formation of a holistic worldview, meant the development of personality in relation with the world, as a process through specialisation. The inner formation also enables the formation of the outer world according to the will of a person. Therefore, Bildung can be conceived as powerful knowledge because it enhances opportunities for self-determination and agency as a member of society. Deng (2020) has proposed that the concept of Bildung would be an important enhancement to powerful knowledge because it broadens the focus on the purpose of education. According to Deng, knowledge cannot be powerful in itself; knowledge is powerful only if its purpose is to cultivate general human capabilities in the spirit of Bildung.

Objective of boundary crossing: Curriculum coherence

Muller and Young (2019) have stressed that powerful knowledge cannot just be a list of topics, but that it needs coherence to support studying. Powerful knowledge is constructed when students are better acquainted with disciplinary ways of thinking, for example, how to *do* history or to *do* physics. For Muller and Young, the key questions for curriculum design are how to select, sequence and pace knowledge from the academic parent disciplines for the educational purposes of school subjects, so that the body of knowledge is arranged optimally.

Muller and Young link the coherence of school subjects with the cohesion found in various disciplines. For this reason, their claims have sometimes been associated with the first educational scenario. Muller (2009) claims that disciplinary forms of knowledge put constraints on curricular design. In the hard disciplines, such as natural science, the spine is best studied *vertically* as within-topic progression, in which the earlier phases are the prerequisite to further advancement. Then, the sequencing of studies is essential for maintaining coherence. In the soft disciplines, such as humanities, the progress is rather narrative and advances *horizontally* through deepening and expanding a network of knowledge (see Bernstein, 2000; Muller & Young, 2019). Therefore, when the boundaries of various fields of knowledge are crossed, it needs to be noted that not all forms of knowledge can be equally integrated with each other and that if the structure of a discipline is broken, gaps in conceptual advancement might occur.

The way Muller and Young stress the importance of specialised subjects and their inner dynamics as the source for coherence resembles the structure of the disciplines

movement in the United States that was popular in the 1960s (Deng, 2015a). A problem that Kliebard (1965) noted with the movement was that the focus was on the inner structure of the subjects, but the coherence of a curriculum as a whole did not receive enough attention. When the coherence of a curriculum as a whole is examined, *verticality* refers to the scope of knowledge being studied throughout the different grade levels. While considering the vertical sequence, in addition to the structures of the disciplines, the way knowledge is organised can be decided on a psychological, pedagogical and educational basis. In turn, *horizontal* curricular coherence refers to the scope of knowledge being studied simultaneously and to the cohesion among subjects (Tanner & Tanner, 2007; Thijs & Akker, 2009).

According to Fortus and Krajcik (2012), a coherent curriculum is constructed in a way that supports teachers to teach in a developmental manner. This means that the curriculum is designed to support teachers in understanding the connections between and within subjects and how learning progresses cumulatively. As Hargreaves (1991) claims, before students can experience coherence in schoolwork, teachers must first experience the curriculum as coherent, thereby making it manageable.

Challenges of boundary crossing

Tyack and Cuban (1995) have identified the integration of school subjects as one of the major recurring innovations in the history of U.S. public schools, but nonetheless challenging the traditional grammar of schooling has proven difficult. Interest in integration is aroused time and again until the challenges are fully realised, resulting in a loss of interest and it being replaced by other points of focus in school development. The results of integrative efforts have varied. Paradoxically, the reshuffling of knowledge can lead to deepening fragmentation (Siskin, 2000). Tyler (1992) notes that blurring the boundaries of the curriculum may result in undifferentiated rather than integrated outcomes. Gardner and Boix-Mansilla (1994), for their part, describe the risk of falling to a pre-disciplinary level rather than achieving an interdisciplinary level.

Muller and Young (2019) state that without the structure of knowledge, students and teachers easily become lost and learning suffers. Therefore, Young (2014) advocates for a subject-based curriculum that helps structure knowledge for classrooms. Young sees the question of integration as important but difficult to solve on the curricular level. Consequently, for Young boundary crossing is primarily a pedagogical, not a curricular, question.

Pountney and McPhail (2019) propose that pedagogical boundary crossing can provide access to powerful knowledge, although they note that it must be approached with caution. When a subject-based curriculum is integrated on a schoolwide level, the role of teachers as curriculum makers expands. Thus, the demands placed on teachers' knowledge of content, pedagogy and curriculum increase and the success of boundary crossing depends on how the teachers manage their task of designing integrative curricular elements and pedagogical practices, which is a challenge especially for subject teachers (Niemelä & Tirri, 2018; Pountney & McPhail, 2019; Kneen *et al.*, 2020). The less boundaries are maintained, the more challenging the implementation becomes and the more teacher commitment, professional development

and time and resources for planning are needed (Gresnigt *et al.*, 2014). Further, teachers expect materials that will support curriculum innovation and it would be unrealistic to presume that teachers would develop the necessary materials for teaching themselves (Tanner & Tanner, 2007; Thijs & Akker, 2009). Therefore, if teachers are not supported by a well-planned coherent curriculum, it is difficult in practice to achieve high-quality integration (Hargreaves, 1991).

The mainstream approach to curriculum integration stresses the active role of students as curriculum makers (e.g. Beane, 1997). Challenges are encountered in the need for acknowledgement, showing that boundary crossing increases the demands for students as well. First, students face demands in realising what is essential to study, as they do not have the expertise to determine what they do not know (Kirschner & van Merriënboer, 2013). Second, today many online resources are applied as sources for inquiry, but research shows that students do not do a good job at estimating the reliability of various sources (Breakstone *et al.*, 2019). Third, there is evidence that learning outcomes decline when students are given too much responsibility for regulating the studying process (Kirschner *et al.*, 2006). Therefore, the objective of classroom work should not be to provide boundless opportunities, but to maintain boundaries and thus, make ordering and orientation possible (Menck, 2000).

It seems like the question of boundary crossing cannot be left to teachers and students alone. As Westbury has claimed (Ruzgar, 2018), schools have limited resources for inventive curriculum work. Before moving on to alternatives for integration that can support classrooms, the conception of curriculum is opened up to clarify the levels at which the discussions are taking place.

The meaning of curriculum

Drawing from the work of Goodlad (1979), Thijs and van den Akker (2009) split the meaning of curriculum into three main levels. The first level is the *intended curriculum*, which takes its form as the *ideal curriculum* and *written curriculum*. The ideal form refers to the level where the purpose of schooling in general is debated and its ideological base formulated. The ideals are then reflected in the form of the written curriculum, in which specified intentions are written up as documents and materials. Planning of the written curriculum consists of selecting and organising the knowledge and objectives for schoolwork. A central aspect of this work is to design school subjects by transforming scholarly knowledge for educational purposes, a process Bernstein (2000) has referred to as the recontextualisation of knowledge.

The second level in which the curriculum is represented is the *implemented curriculum*, which stresses especially the role of teachers (Thijs & Akker, 2009). At this level, the curriculum takes its form based on the way it is interpreted by its users and then operationalised as part of the teaching-studying-learning process. The third and final level is *attained curriculum*, which concerns the students, how they experience the curriculum as schoolwork and what kinds of learning results they will achieve.

A crucial question for curriculum studies is, how are the aims of the intended curriculum actualised in everyday schoolwork? Westbury (2008) has rather sceptically claimed that the influence of a written curriculum at the classroom level is at best uncertain. Westbury sees the function of a curriculum mainly as an ideological

instrument that constructs the narrative of schooling for teachers and for the public. However, Westbury appreciates school subjects as essential building blocks that organise the inner work of schools and serve as the foundation for professional teacher communities. According to Westbury, subjects stabilise the delivery of schooling.

The specialisation of teachers to teach certain subjects makes it difficult to introduce new knowledge or restructure the older fields of knowledge in a curriculum. A sort of path dependency exists and it limits what a curriculum can be in actuality. Bernstein (2000) has remarked that changes in the classification of knowledge meet with resistance because established power relations, identities and inner psychic systems are threatened. Thus, the selection and organisation of curricular knowledge reflects *the knowledge of the powerful*. According to Goodson (2014), the powerful used to comprise the inner groups of schooling, such as teacher communities and curriculum experts, but recently it has become internationally evident that schooling is facing increasing external pressure.

Boundary drawing and crossing in organising knowledge for coherent curriculum design

As previously shown, integration at the classroom level is demanding and in need of support. Therefore, integration of knowledge that makes it possible to maintain boundaries between specialised and everyday knowledge and coherent conceptual progression must be considered at the level of the written curriculum.

A subject-based curriculum is not the opposite of an integrated curriculum. Actually, it would be difficult to find a curriculum that is not integrated in one sense or another (see Pring, 1971). As Carr (2007) states, one can stress the role of disciplinary forms of knowledge as the foundation for curricular design and simultaneously present various alternatives for their coherent organisation as a subject structure. Following a similar line of thought, Oates (2018) claims that Young's theory does not rule out knowledge integration. The open question is how knowledge should be organised within a curriculum, a theme that has been largely neglected in curriculum studies in recent decades (Deng, 2015b).

To show more concretely why knowledge integration is compatible with the idea of powerful knowledge, the primary question is, what alternatives for integrating knowledge at the level of written curriculum have the potential to support the development of powerful knowledge? More specifically, the question is first about the number and place of the curricular boundaries for building internally coherent subjects. Second, the question is about the crossing of these boundaries to achieve coherence as a whole. To answer these questions, disciplinary knowledge from the field of history is used as an example of how a subject can be integrated while designing a curriculum.

The place and range of boundaries

The most strongly classified alternative for organising knowledge in a curriculum is to maintain boundaries according to the various academic disciplines (Tanner & Tanner, 2007). However, it is rare that a subject is formed by recontextualising knowledge directly from a single discipline. Broadly speaking, because academic disciplines

are continuously becoming more specialised, the knowledge being recontextualised is integrated instead from a region of sub-disciplines (Bernstein, 2000). For example, history, as *a subject* that carries the name of an academic discipline, can fuse a selection of knowledge from various sub-disciplines, such as political history, economic history, national history, world history, history of ideas and historical anthropology.

The number of boundaries in a curriculum can be reduced by expanding the scope of subjects. This allows for conceptual structuring within a broader field of knowledge. If the structuring is functional and the size of a subject remains manageable for the teaching-studying-learning process, it has the potential for developing powerful knowledge. A well-connected structure aids students in transferring concepts from one particular use to another context and between the abstract level and application. Integrating various knowledge structures is essential for learning, but research shows that students struggle in doing that spontaneously (Schneider & Stern, 2010). Therefore, knowledge integration requires *deliberative* attention. As in the previous example of history, integration of the various sub-disciplines makes the structure of historical knowledge more coherent and thus, more accessible for students.

When the scope of subjects is expanded, the disciplinary knowledge of history can be organised as part of *a regional subject*. Within the integrated subject of social studies, history can be coupled with social sciences and geography. Further, within the broad field of humanities, history can create a whole with, for instance, visual arts, music and literature. Subjects with a wider scope can also be problem-based or organised around a theme. For example, Klafki (1991) has proposed a curricular model that is built around the key problems of the current epoch. At the end of the Cold War, Klafki defined five key problems: (1) peace, (2) state of the environment, (3) inequality, (4) technological development and (5) the I-You relationship. In Klafki's model, these issues are studied alongside traditional subjects as thematic wholes, which integrate perspectives from traditional subjects and serve as the grounds for studying problem-related content and skills. However, thematic subjects run the risk of undermining the disciplinary structures of knowledge. Therefore, Klafki's model also maintains the place of traditional subjects.

Boundary-crossing points

Another approach to the integration of subjects does not aim at reducing boundaries but focuses on crossing them instead. The number of boundaries can even be increased to structure integration. It is essential to consider when the content, concepts and objectives of subjects are converging and how it would be possible to build boundary-crossing points that would allow the perspectives of subjects to collaboratively support the teaching-studying-learning process.

Within the paradigm of the second scenario, the planning of the boundary-crossing points is given to the teachers and students. However, as argued above, curriculum innovation is a challenging task as part of everyday schoolwork. Thus, it would be advantageous to design the boundary-crossing points to fit into the written curriculum. This would allow for the development of teaching and studying materials and teacher education for the boundary-crossing points, that is, the development of teachers' integrative pedagogical knowledge (Niemelä & Tirri, 2018).

But what do these powerful boundary-crossing points mean? A few alternatives are available. The first, *correlation* is a commonly cited example. It means boundary crossing between subjects while the subject structure remains intact (Tanner & Tanner, 2007). This can be achieved through teaching arrangements. Hence, it concerns mainly pedagogy and local curriculum organisation. For example, a history teacher can collaborate with a teacher of literature to study *in parallel* the history and literature of an epoch. Lessons can also be *sequenced* by, for example, first studying specific vocabulary in a foreign language and then studying historical sources in that language. Since these kinds of pedagogical alternatives to integration expand the demands placed on teachers as curriculum makers, correlation can be supported by dividing a school year into periods with an alternating focus. One period can emphasise, for instance, humanities or natural science, allowing for better coordination within these subject groups. Furthermore, *periodical studies* reduce boundaries by decreasing the number of subjects studied concurrently.

Second, boundary-crossing points can be deliberatively designed within the structure of a subject. One alternative is to form *core subjects* that comprise the spine of the curriculum to which other subjects are connected. At the turn of the 20th century, Herbartians advocated for history as a core subject. According to the principle of integration, students would recapitulate the development of civilisation epoch by epoch during different school years (Tanner & Tanner, 2007). The risk to such an approach is that when the structure of one subject dominates others, it can hinder the coherence of other subjects. However, if a core subject does not assume a role of dominance and succeeds instead in forming a connective structure, it can serve the overall coherence of a curriculum and thus advance powerful knowledge.

Third, *connective subjects, courses and units* can be designed for the purpose of boundary crossing. These are examples of how strong classification and boundary drawing can serve the purpose of integration. For instance, architecture, an applied discipline and a profession, as a connective school subject could integrate perspectives from history, geography, visual arts, crafts and mathematics and serve as a crossing point in between them. Garcia-Huidobro (2018) has presented the theory of knowledge course included in the International Baccalaureate Diploma Program as an integrative element supportive of powerful knowledge. The course is connective by its very nature, as it covers the epistemological questions relevant for all subjects. Further, smaller scale units can be planned to connect subjects, for instance an archaeology unit when integrating history with physics to study radiocarbon dating. Units can be planned as parts of the subjects, as meeting points for collaborative work or as advanced or optional courses.

Fourth, *optionality* is in itself an integrating principle from the student's point of view because it makes it possible to concentrate studies for better coherence within a sector of a curriculum. Students' integrative efforts can be given room also through capstone courses or diploma work. *Capstone courses* allow students to apply knowledge and skills in the form of a project, the topic of which can be decided by the students themselves (Kilcommins, 2015). *Diploma work* is usually done individually in the form of a thesis or portfolio integrating what a student has learnt as a whole. Capstone courses and diploma work that are preceded by subject-based studies make

it possible to practice the use of concepts in diverse contexts, which Oates (2018) claims is important for the development of powerful knowledge.

Fifth, *cross-curricular integration* refers to the objectives shared by different subjects. One of the most characteristic features of curricula conforming to the second scenario is the emphasis on 21st-century competences as cross-curricular learning objectives (Young & Muller, 2010). In cognitive science, teaching domain-general competencies is an ineffective instructional approach (Schneider & Stern, 2010). Therefore, teaching competences can hardly result in powerful knowledge, but powerful knowledge may well result in different competences. As Deng (2020) has claimed, general competences can be valuable educational aims if they are embedded in subject matter. Then, competences are not approached as abstract entities, but through the content of subjects, which give substance to, for instance, the development of multiliteracy or critical thinking. Although implementing such an approach is again challenging if it is simply given as one more task for teachers (see Hargreaves, 1991). Overall, the central aim of organising curricular knowledge is to make it manageable for the teaching-studying-learning process.

Conclusions

The purpose of this paper was to contribute to discussions on powerful knowledge by formulating an argument for why and in what ways boundary crossing is essential when developing a curriculum representative of the third educational scenario for the future. First, the paper summarised the discussion on educational scenarios. Then, it argued for the importance of both maintaining and crossing the boundaries of knowledge for schooling. It demonstrated why boundary crossing should not be considered predominantly at the classroom level, arguing that it is vital to recognise how knowledge is differentiated and integrated at the level of the written curriculum. Lastly, it presented alternatives for drawing and crossing the boundaries of curricular knowledge in a way that supports the development of powerful knowledge.

The three educational scenarios can now be distinguished from the perspective of curriculum integration. The first scenario downplays the questions of integration and curriculum coherence as a whole, and it focuses on academic disciplines. The commitment of Young and Muller to the structures of disciplines have brought their thinking close to the first scenario, although they have remained open to boundary-crossing efforts. The second scenario undervalues the role of the structure of knowledge for learning and highlights integration, seeing it as being best accomplished through pedagogical practices. Here, it was suggested that the third scenario depicts a type of schooling in which the structures of knowledge are maintained in various school subjects and the subjects are connected in such a way that deliberate integration takes place already at the level of curriculum design, which aims at constructing a coherent curriculum as a whole. The presented alternatives for knowledge-based integration give concrete propositions for schools and curriculum design regarding how to implement integration efforts when advancing the third educational scenario.

Finally, educators must decide the most appropriate places for curricular boundaries and their crossing points for each grade level in a manner that is suitable for the

teaching-studying-learning process and for specific educational purposes. Written curriculum is commonly designed in subject-based committees, which have limited communication with each other (Westbury, 2008). In contrast, Schwab (1978) has proposed that the curriculum design process should be done in collaboration with groups of experts in a process led by curriculum specialists. In present-day terminology, the process Schwab described can be counted as interdisciplinary cooperation between educational psychologists, sociologists, philosophers and historians of education, teachers and teacher educators and disciplinary experts of subject matter. This kind of process would make it possible to chart connective concepts for the design of both vertically and horizontally coherent written curricula that promote powerful knowledge.

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