Interdisciplinarity in Teacher Education

A mixed-methods study exploring prospective teachers' perceptions and experiences with interdisciplinarity.

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I took this course in the hopes of changing the course of my life, not realising how much I would change along the way. Despite a lot of anxiety and a lot of hard work, I am incredibly proud of this thesis, which I hope can be a starting point for continuing to contribute to the field of interdisciplinary education.

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Abstract: *This thesis takes a mixed-methods approach to hear how prospective teachers understand and experience interdisciplinarity in their teacher education. Interdisciplinarity is a resurgent phenomenon in education, with society demanding innovation to solve complex problems. In the recent Norwegian curriculum reform, LK20, three interdisciplinary themes have been introduced, expected to span the entire pedagogical discourse. This has been problematic, with a lack of thorough implementation in curriculum documents and teachers feeling uncertain. Prospective teachers have the opportunity to enter the profession with interdisciplinary integrative ability. However, in this study, prospective teachers report little experience with interdisciplinarity in university and while they meet more interdisciplinarity in praxis, there is a lack of authentic experiences and confident role models. Furthermore, the informants claim an increased focus on subject-specialization, a lack of program coherence and explicit didactics in their teacher education means they are unprepared for the forced interdisciplinarity required in schools. This thesis proposes a profession-oriented, generalist teacher education program with explicit focus on didactics and interdisciplinarity which aims to increase teacher preparedness, professional autonomy and program coherence*.

Denne oppgaven tar en mixed-methods tilnærming for å høre hvordan fremtidige lærere forstår og opplever tverrfaglighet i lærerutdanningen. Tverrfaglighet er et gjenoppstått fenomen i utdanning, der samfunnet krever innovasjon for å løse komplekse problemer. I den nyligste norske læreplanreformen, LK20, er det introdusert tre tverrfaglige temaer som forventes å gjennomsyre over hele den pedagogiske diskursen. Dette har vært problematisk, med manglende gjennomføring i læreplandokumentene og lærere har følt seg usikre. Potensielle lærere har mulighet til å gå inn i yrket med tverrfaglig integreringsevne. Men i dette studiet rapporterer fremtidige lærere lite erfaring med tverrfaglighet på universitetet og mens de møter oftere tverrfaglighet i praksis, mangler de autentiske tverrfaglig opplevelser og selvsikre rollemodeller. Videre hevder informantene økt fokus på fagspesialisering, manglende programsammenheng og eksplisitt didaktikk i lærerutdanningen gjør at de ikke er forberedt på den tvungne tverrfagligheten som kreves i skolen. Denne oppgaven foreslår et profesjonsrettet, "generalist" lærerutdanningsprogram med eksplisitt fokus på didaktikk og tverrfaglighet som har som mål å øke lærerberedskap, autonomi og programkoherens.

Keywords: interdisciplinary, cross-curricular, tverrfaglig, teacher education, lærerutdanning, student perspective, interdisciplinarity, program coherence, integrative, LK20, interdisciplinary tertiary education, transformative, koherens, multidisciplinary

1.0. Introduction & Study Aims

There has been a resurgent interest in recent years for interdisciplinarity in education, yet there is very little research in the area (Gombrich & Hogan, 2017[1]). Interdisciplinarity is not only a resurgent pedagogical strategy, but a complex one, transcending the traditional boundaries of disciplinary knowledge (Klein, 1990). Interdisciplinary practices are in demand due to their potential for creating innovative solutions for complex problems (Paulsen Dagsland, 2022; Schjif, 2022; Boix Mansilla, 2005; Deneme & Ada, 2012; Hayes, 2009) with Frodeman (2017) claiming interdisciplinarity could be "central to the transformation of the twenty-first century university" (p.6). Yet its' implementation poses difficulties to educational institutions who have traditional disciplinary structures and identities (Turner, 2017; Vasutova, 1999). A lack of common interdisciplinary definition and discourse further complicates its' implementation (Klein, 2006).

In the latest Norwegian curriculum, Knowledge Promotion 2020 (LK20), interdisciplinary teaching and learning has been included in a substantial way, with three interdisciplinary themes: Democracy and Citizenship, Sustainable Development, and Health and Life Skills spanning all levels of education (Education Department, 2017; NOU2015:8). The three themes have been linked by the Ludvigsen Committee to Wolfgang Klafki's Key Problems and are aimed at specific societal problems, climate change, waning democracy, and burgeoning pressure on the health sector (NOU2015:8, p.49, footnote 24). The themes are expected to permeate the curriculum, across all subjects from elementary to senior high school. It has been introduced to encourage pupils to look across traditional subject borders and make new connections from different perspectives. These connections are deemed essential in inspiring innovation and to develop 21st century skills, such as communication and collaboration (Education Department, Core Curriculum 2017). In schools, interdisciplinary teaching and learning have different requirements for teachers and pupils. Teachers need to collaborate in different ways, often across disciplines and learn to facilitate interdisciplinary inquiry (Petroelje-Stolle & Frambergh Kritzer, 2014). As the main conduit between the government and schools, the university is responsible for recontextualizing governmental intentions for their transmission to schools (Bernstein, 1996). In a report from

[1] Please note page numbers are not used apart from direct citations, in line with APA7 English guidelines and recommendation of my supervisor.

the Centre for Educational Research and Innovation (CERI) titled *Interdisciplinarity: Problems with Teaching and Research in Universities* (1972) the authors claim that "the key to any change lies in teacher training" (p.234). For this reason, Koritzinsky (2021), Borromeo Ferri (2016) and Klein (2006) amongst others, claim there needs to be an interdisciplinary focus in teacher education, with Borromeo Ferri (2016) claiming that the successful implementation of interdisciplinarity in schools “stands or falls on the state of teacher preparation for it” (p.259). If an interdisciplinarity is not experienced in teacher education, it may be considered a threat to teacher professionality, where teachers are "being called upon to perform tasks for which they have not been educated" (Brooks in Schön, 1991 p.14).

Spelt et al.'s (2009) systematic review of interdisciplinary literature revealed very few empirical studies on interdisciplinarity in higher education, and zero publications based on the perspective of the students (Xu et al., 2022; Gombrich & Hogan, 2017). According to Canrinus et al. (2017), focusing on the students' experiences is essential, as it is the *experienced* curriculum that is significant, as opposed to the *intended* curriculum. A teacher education program may be designed with certain goals or aims in mind, but these may not be received by students as they were intended. Graybill et al. (2006) claim that "without understanding students’ experiences in interdisciplinary programs, faculty will not know whether they are “getting it right” for future generations of interdisciplinarians" (p.757). Taking a student perspective will provide a more accurate overview of how a curriculum is received and also provide information about experienced interdisciplinary practices in both university and in praxis schools.

Following the work of Spelt et al. (2009), an updated and more generalised literature review has been conducted for this thesis. This uncovered few empirical studies which focus on the student perspective of tertiary interdisciplinary approaches (Xu et al. 2022; Gombrich and Hogan, 2017; Graybill et al. 2006) and in interdisciplinary teacher education (Beudels et al, 2021; An, 2016; Self & Sang Baek, 2016; Petroelje Stolle & Frambaugh-Kritzer, 2014; Parker et al. 2012; Hammond & McCallum, 2009; Spalding, 2002; Kaufman & Grennon Brooks, 1996). This is not an exhaustive list, however, almost all of the studies found have measured student responses or perceptions of interdisciplinarity *after* a planned and executed intervention. One exception is a study by Parker et al. (2012) who asked prospective teachers about their experiences with interdisciplinarity in their prior schooling, and how they perceived interdisciplinary teaching and learning pre- and post-intervention.

An aim of this study is to contribute to the limited research on interdisciplinarity in teacher education, to help fill the gaps identified by Vess (2001) who claims,

> *although interdisciplinarians are building on an exceptionally strong foundation in the scholarship of teaching and learning, . . . [m]ore work needs to be done to better chart the connections among theory, pedagogy, course enactment, and student perceptions of the learning environment; further, we need to explore connections between the enactment of various models of interdisciplinarity and actual learning as reflected in coursework and later performance.* (p.96)

This thesis will use a convergent, explorative mixed-methods design to find out how prospective teachers understand and experience interdisciplinarity in teacher education, which could possibly be used as a starting point for reviewing teacher education and current school practices. Implementation of interdisciplinarity has been problematic in the Norwegian context with evidence citing an ambiguous discourse (Karseth et al, 2020), and a lack of professional knowledge, confidence and/or motivation (Paulsen Dagsland, 2022; Fostervold Bakken, 2021[2]; Koritzinsky, 2021; Sinnes & Straume, 2017; Sinnes and Jegstad, 2011). This deemed a mixed methods approach appropriate, to not only understand the frequency of interdisciplinarity in teacher education but the nature and quality of these experiences. A final aim for this study is to hypothesize how well prospective teachers are prepared for the challenges of interdisciplinary teaching and learning in the workplace and propose changes which may be needed.

1.1 Research Questions

The outlined aims have led to the development of the overarching research question:

How do prospective teachers experience interdisciplinarity in teacher education?

To answer this research question two sub-questions have been created:

[2] Please note that due to a lack of empirical literature in the Norwegian context, master theses have been used. For example, Bae Solvang, 2021; Fostervold Bakken, 2021; Rikardsen Jaatun, 2021; Hansen, 2020 and Narvesen, 2019

1. How do prospective teachers perceive interdisciplinarity as a pedagogical approach?
2. To what extent and in which ways do prospective teachers experience interdisciplinarity in,
    a) university?
    b) in praxis schools?
    c) How do these compare?

2.0 Literature

To understand interdisciplinarity this thesis will focus on the work of Judith T. Klein, primarily the texts, *Interdisciplinarity: History, Theory and Practice* (1990) and *A Platform for a Shared Discourse of Interdisciplinary Education* (2006). When considering factors that may influence the implementation of an interdisciplinary curriculum, this thesis will present the categories created by Spelt et al. (2009) *Teaching and Learning in Interdisciplinary Higher Education: A Systematic Review*. These categories are Interdisciplinary Thinking, Student Characteristics, Learning Environment & Learning Outcomes.

2.1. Disciplinarity & Interdisciplinarity

Since Antiquity, there have been discussions regarding the acquisition, development and classifications of knowledge. Aristotle advocated for clearer demarcations and segregations of knowledge, a precursor to today's disciplines, for example, politics, theology and astronomy (Klein, 1990). The term *discipline* has evolved from Latin, *disciplina* which translates as, "to educate one's disciples" (Klein, 2006 p.10). Disciplines evolved in response to societal needs and demands, and as they developed exclusive knowledge to address a particular problem, disciplines gained power and legitimacy. Disciplines originally took the form of merchant guilds, as well as professions of medicine and law (Klein, 1990). Disciplines became the *gatekeepers* of knowledge, leading to the creation of an internal language, epistemological standpoints, conceptual "truths" or "laws", accreditation rituals and/or academic exclusion, so much so, that Turner (2017) claims that the term *discipline* correlates to "protection of the dogma" (p.15).

By 1910, disciplines became the foundation for the modern university, with Klein (1990) stating that, "growing particularization of knowledge was also to have a profound impact on the structure of higher education" (p.21). These disciplines become social entities, providing a

sense of identity to individuals permitted to enter (Jacobs 2017, p.36). Faculties, institutes and departments all fight to justify their existence, fiercely protecting their academic territory and disciplinary integrity (Klein, 1990). Established disciplines prize their status, and often act in a way to retain their status, rather than to innovate or alter the status quo (Turner, 2017). This has triggered critique and a countermovement of interdisciplinarity.

While frequently considered a new phenomenon, Klein (1990) says that the concept of interdisciplinarity also emerged in Antiquity, with grand theories of a universal set of knowledge. Theorists Bacon, Comte, Descartes, French Encyclopedists, Hegel and Kant feared overspecialization and were concerned that a lack of liberal education was not sufficient to fully develop a man (Turner, 2017; McCulloch, 2012; Klein, 1990).

There is a general consensus that interdisciplinarity involves a crossing of traditional subject disciplinary boundaries, for example from Frodeman (2017); Klein, (2017), McCulloch (2012), Boix Mansilla (2005), Newell (2002) amongst many others. However, Klein (1990) explains that interdisciplinarity is a very open concept, which gives it "a universality and complexity that seem to defy definition" (p.11). She provides three reasons for this:

1. *General uncertainty of the term, no clear definition of theory, methodology or pedagogy.*
2. *That interdisciplinarity is still relatively underreported phenomenon in scholarly literature. Those who do write about it are still unsure "whether there should be professional interdisciplinary movements, fearing the insularity that has accompanied the professionalization of other areas".*
3. *A lack of a unified body of discourse. Discussion "sprawls across general, professional, academic, governmental and industrial literatures"*

(paraphrased and quotes from pp.12-13)

Interdisciplinary work is not united under a common umbrella of methods or terminology. In fact, it may be quite overwhelming to try and create such an umbrella as "the need for meaningful interaction is everywhere" (Kockelmans to Klein, 1990 p.13, personal communication). Benson (1982) is more critical, claiming that disciplines constantly borrow from other disciplines, with no one claiming interdisciplinarity has occurred. However, interdisciplinary practices are implemented to differing degrees and in a variety of ways,

without clear demarcation or definition. These organic processes occur in everyday situations, "ranging from formal, *overt* structures to a *concealed* presence that may flourish where it is not even labelled as an interdisciplinary activity" (Klein, 1990 p.40). However, this has not dissuaded attempts to delimit and define interdisciplinarity.

2.2. The Many Guises of Interdisciplinarity

In a first major attempt to clarify an interdisciplinary discourse, the Centre for Education Research and Innovation (CERI), sponsored by the OECD, published a report in 1972 entitled, *Interdisciplinarity: Problems of Teaching and Research in Universities* (Klein, 2017, 2006, 1990; McCulloch, 2012; Apostel et al, 1972). They define interdisciplinarity as,

> *An adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organising concepts, methodology, procedures, epistemology, terminology, data, and organisation of research and education in a fairly large field. (pp.25-26).*

This definition in itself is still broad and all-encompassing, ranging from sharing an idea, up to integrating epistemologies and methodologies. In terms of education, Jacobs (1989) defines interdisciplinarity as "a knowledge view and curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience" (p.8). Despite also espousing Jacobs' definition, Hayes (2009) also claims that interdisciplinarity,

> *Can be allocated a variety of legitimate meanings. As it does not have a single identity, it cannot be assumed that there is consensus among educators over its' definition, its' implications for curriculum planning or its' significance for teaching and learning. (p.383).*

The lack of a clear definition of interdisciplinarity and a related pedagogical practice has led to the development of many classifications or *levels* of interdisciplinarity which can either add clarity or create further confusion for teachers. Lenoir, Larose and Geoffroy (2000) describe three forms of interdisciplinarity in education: "curricular, didactic and pedagogical" (p.105). However, multiple terms exist, such as: intradisciplinary, pluridisciplinary, multidisciplinary,

interdisciplinary or transdisciplinary education, curriculum integration, integrated teaching, cross-curricular studies, thematic or topic-based approaches (Hilli & Mård, 2022; FIKS, 2020; Parker, 2012; Klein, 1990). Meanwhile, Robin Fogarty (1991) describes ten levels of curriculum integration: "fragmented, connected, nested, sequenced, shared, webbed, threaded, integrated, immersed and networked" (p.xiv). This sheer multitude of terminology contributes to more ambiguity, rather than clarification (Klein, 2006).

The CERI report (1972) categorizes interdisciplinarity in four different ways: *Multidisciplinary, Pluridisciplinary*, *Interdisciplinary* and *Transdisciplinary* (p.25). While Klein generally explains the multiple definitions in most of her works (2017, 2006, 1990), they are perhaps most easily explained in pedagogical terms in *Interdisciplinarity: History, Theory and Practice* (1990). She explains that in *pluri-* and *multi-disciplinary* approaches, disciplinary experts work adjacent to one another on a common problem or theme, while *interdisciplinary* approaches involve experts building upon each other's skills, across disciplinary borders. Meanwhile, *transdisciplinary* approaches involve a team working with a more thorough assimilation of knowledge, transcending traditional disciplinary boundaries. This is the most complex version of interdisciplinary work as it "implies a true totality" with Klein (1990) stating that, "for that reason, transdisciplinary approaches are quite rare" (p.67). An additional element of transdisciplinarity often involves engagement with external agencies, such as institutions or professionals (Paulsen Dagsland, 2022; Spalding, 2002).

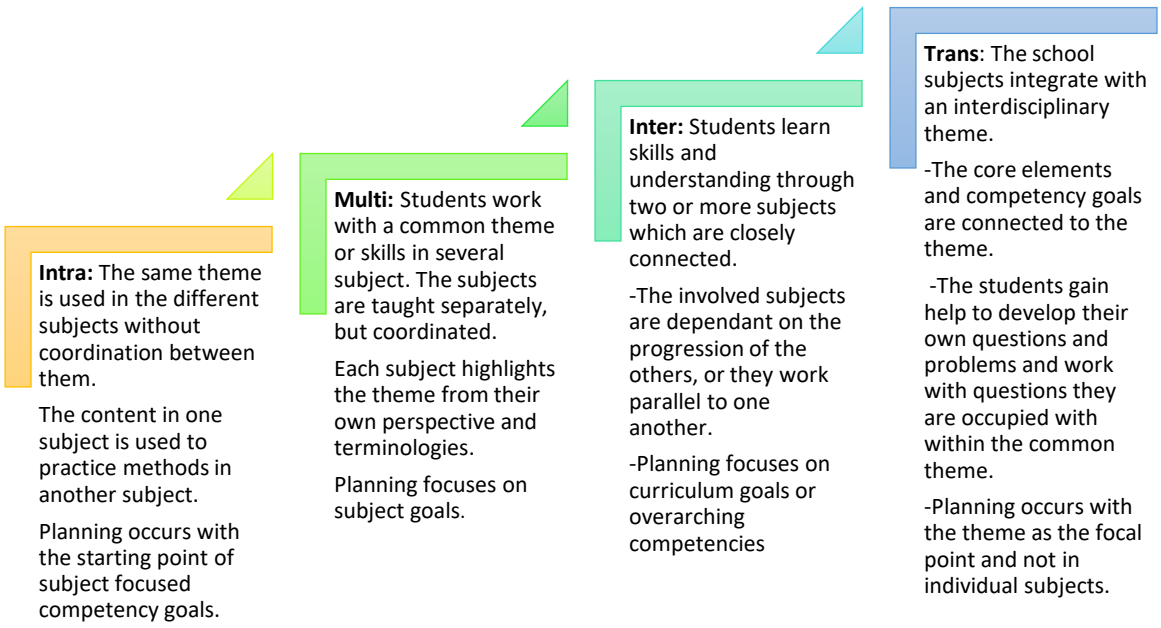
However, differing slightly from the CERI Report, Norway utilizes levels of interdisciplinarity bases its' understanding on the works of Drake & Reid (2018) and Kaufman, Moss & Osborne (2003),focusing on *intradisciplinary*, *multidisciplinary, interdisciplinary* and *transdisciplinary approaches* (FIKS, 2020, Figure 1). The newer term, *intra*disciplinary entails working on the same theme across subjects, with no coordination between them, while the *interdisciplinary* approach adopted by LK20, requires an *integration* of subjects and focus on overarching goals, which has not been emphasized to this degree previously in Norwegian curricula.

2.3. Interdisciplinarity in the Norwegian Curriculum

Interdisciplinarity and reform pedagogy has been a part of the Norwegian curriculum since the 1930's (Bolstad, 2022; Sinnes & Straume, 2017). It became more prominent in later decades as

Figure 1

Norwegian Levels of Interdisciplinarity



translated from: FIKS, 2020.

environmental preservation became a major issue. Sinnes & Straume (2017) explain that this focus was spearheaded by the Brundtland Commission and led to the introduction of interdisciplinarity in the curriculum reform of 1974 (M74). The Commission considered environmental preservation so important that it could not be addressed by one discipline alone. Interdisciplinary approaches continued their influence in later curriculums, with the curriculum in 1987 (M87) highlighting the need for pupils to engage with real-life problem solving (Sinnes & Straume, 2017). In Reform 1994 (R94), project-work became mandatory at all levels of schooling (Bolstad, 2021; Andreassen, 2019) however, interdisciplinary approaches died down from the late 1990's (Andreassen, 2019) with mediocre PISA results leading to a shift in focus towards basic skill development and assessable competencies in both R97 and the curriculum reform of 2006 (LK06) (Aakre, 2022; Sinnes & Straume, 2017; Aasen et al., 2012). This resulted in teachers raising concerns about the impacts of standardization for their pupils and displeased with their own loss of autonomy (Aakre, 2022; Sørreime, 2016). This response from the teachers, continuing demand for societal innovation, and pressure to follow suit in the Nordic countries (Spanget Christensen & Hobel, 2014) led to the appointment of the Ludvigsen Committee to come with recommendations for the new curriculum. This resulted in the White Paper entitled, *The School of the Future: Renewal of Subjects and Competencies* (NOU2015:8). The Government received and altered the report, becoming Parliamentary Announcement 28

(Stortingsmelding 28, 2015-2016) titled, *Subject-Specialization-Understanding*. In this report the focus on interdisciplinarity was reduced whilst retaining the interdisciplinary terminology (Koritzinsky, 2021). This was the foundation for the current curriculum, Knowledge Promotion 2020 (LK20) including three interdisciplinary themes: Sustainable Development, Democracy and Citizenship and Health and Life Skills (Directorate of Education, Core Curriculum, 2017 §2.5).

2.4. Reasons for an Interdisciplinary Curriculum

UNESCO (2003), in its' document, *The International Implementation Scheme for the United Nations Decade of Education for Sustainable Development* identified an interdisciplinary curriculum as a way to promote a holistic education, based on developing values, problem-solving skills and critical thinking (Hammond & McCallum, 2009). An interdisciplinary approach entails using 21st century skills such as communication and collaboration (Xu et al., 2022), which Newell (2018) sees as positive for developing democracy, claiming that “the combination of progressive education and interdisciplinary studies...is the best way to educate future citizens” (p.20).

One of the main reasons for introducing an interdisciplinary approach is to develop a more holistic understanding of a problem or situation, looking across disciplines for innovative solutions which otherwise would remain unattainable (Schjif, 2022; Boix-Mansilla, 2005). Klein (1990) states that due to disciplines' insularity, innovations that are rarely discussed outside of the disciplinary walls, and opportunities to collaborate and share knowledge are limited. She claims that "the cost of avoiding these commonalities is enormous" (p.14). Bernstein (1999) concurs, saying "any restriction to circulation and exchange reduces effectiveness" (p.160).

This has been recognized by governments, leading to a renewed focus on interdisciplinary collaboration and research, and Kleinberg (2008) regarding "interdisciplinarity as a major paradigm of tertiary education" (in La Fever, 2008 p.6). Interdisciplinarity in teacher education is more complex than other tertiary programs, with Bolstad (2020) explaining interdisciplinarity can be understood in two ways; as a description of content spanning different subjects, or as a pedagogical principle and a way to organize ones' teaching (paraphrase from p.1).

2.5. Implementation of an Interdisciplinary Teacher Education Programme

In order to introduce interdisciplinarity to the Norwegian curriculum, many claim it is necessary for prospective teachers to learn about and experience interdisciplinarity in their teacher education (Koritzinsky, 2021; Borromeo Ferri, 2016; Hammond & McCallum, 2009; Klein, 2006; Spalding, 2002; Kaufman & Grennon Brooks, 1996), with Kaufman & Grennon Brooks (1996) stating that, "if teachers are to collaborate in schools and create enhanced interdisciplinary classroom environments that better foster students' linguistic and academic growth, they must experience such pedagogy in teacher educational programs at the university" (p.231). Klein (2006) makes a stronger claim saying, "interdisciplinarity has become more central to knowledge. It must not be peripheral to teacher training at all points of the career life cycle" (p.16). Borromeo Ferri (2016) concurs, saying that the successful implementation of interdisciplinarity in schools “stands or falls on the state of teacher preparation for it” (p.259). This is in line with the theories of Darling-Hammond et al.(2005), who claim that what prospective teachers learn in their teacher education follows them, influencing their professional practice. They found that prospective teachers who participate in reform-oriented professional development "tended to focus on students' own strategies and purposes" (p.396), as opposed to prospective teachers who experienced more traditional programs. Interdisciplinarity in teacher education is two-fold: to develop interdisciplinary knowledge and skills in prospective teachers (Schjif, 2022; Spelt et al., 2009), but also to familiarise them with interdisciplinary pedagogy and didactics (Borromeo Ferri, 2016).

In a system which recently only has focused on outcomes and accountability (Christensen, 2003), Klein and Newell (2002) claim that "many educators are not prepared for interdisciplinary teaching, administration and curriculum development" (p.141). Despite advocates calling for interdisciplinary approaches in tertiary education, Le Fever (2008) claims that "cultivating relationships between fields of interdisciplinary studies and teacher education programs [is] rare" (p.4). Borromeo Ferri (2016) attributes this to a lack of "systematic teacher education in this field in many European countries" and continuing by saying,

> *The implementation of an interdisciplinary approach, from kindergarten age to school, and university, levels, is still a challenge for teachers, and for those who are educating the teachers. Interdisciplinary learning and teaching require, on the one hand, well-prepared teachers, and on the other hand, adequate teaching materials for*

every-day lessons in school (not to speak of curriculum and assessment regimes) (p.259).

Implementing interdisciplinarity in a traditionalist education system may be daunting (Turner, 2017; Klein, 2006), therefore a number of factors must be considered if its' implementation is to be successful. Interdisciplinarity is an example of a constructivist pedagogy (Spelt et al. 2009; Klein, 2006; Kaufman & Grennon Brooks, 1996) where experiences are needed that provide opportunities for a student (or pupil) to construct their own knowledge. Biggs and Tang (2011) created a conceptual framework for planning and assessing constructivist learning experiences which focuses on learning outcomes, student attributes, learning environment and learning process. Interdisciplinary research by Xu et al. (2022) and a literature review by Spelt et al. (2009) both utilize Biggs & Tang's framework, adapting the four headings to: Learning Outcomes, Interdisciplinary Thinking, Student Characteristics and Learning Environment. Both Xu et al. (2022) and Spelt et al. (2009) consider the *learning outcome* of interdisciplinary education to be the development of Interdisciplinary Integrative Ability. This requires the development of interdisciplinary thinking, enhancement of positive student characteristics and a pedagogy which enables prospective teachers to experience and learn interdisciplinary approaches.

2.5.1. Interdisciplinary Thinking

There are many ways to categorise the development of skills necessary for working in an interdisciplinary manner. From a survey of interdisciplinary experts (N=505), Larson et al. (2011) identified "seventeen competencies under three main themes: conducting research, communication and interacting with others" (p.39). Meanwhile, Spelt et al. (2009) differentiate the development of interdisciplinary thinking into only two categories: *interdisciplinary knowledge* and *interdisciplinary skills*. However, Schjif et al.(2022) takes Spelt et al.'s categories further, designing six categories: knowledge of different disciplinary paradigms, knowledge of interdisciplinarity, communication and collaborative skills, reflection skills and critical reflection skills (p.1).

Knowledge of Disciplinary Paradigms

It is widely acknowledged that developing interdisciplinary knowledge requires knowledge of disciplines and disciplinary paradigms (for example, McCulloch, 2012; Klein, 2006; Boix Mansilla, 2005) with McCulloch (2012) claiming that "interdisciplinarity should be understood as the integration of concepts and methods from disciplines" (p.12). It may seem contradictory focusing on disciplinary knowledge, but it is important to acknowledge that interdisciplinarity generally seeks to utilize disciplinary knowledge, methodologies and skills from different fields in order to provide innovations which singular disciplines cannot. Boix Mansilla (2005) explains that "the integration of disciplinary perspectives is a means to an end, not an end in itself. Disciplinary standards are upheld and leveraged. To achieve the end in question is gained by combining disciplinary lenses" (p.16). Here Boix-Mansilla describes interdisciplinarity as a process, rather than a product. This is one reason interdisciplinarity has been introduced in LK20 together with another concept, deep learning. According to Bolstad (2020), interdisciplinarity has been introduced as a vehicle for deep learning and increasing content knowledge in more than one subject. Yet some scholars, faculty and students dispute that interdisciplinarity is such a vehicle, feeling instead that it waters down specialization (Xu et al., 2022; Benson, 1982) or may been seen as denigrating the necessity of disciplines (Jacobs, 2017).

However, in a pedagogical sense, it is an intention of interdisciplinarity that teachers can make relevant and meaningful connections across disciplines for their students, to enable deeper understanding of a concept or issue (Parker et al. 2012). This indicates a degree of content knowledge across disciplines is required, something which Benson (1982) claims is a necessity, arguing that "it is a pedagogically doubtful business to spend time in interdisciplinary learning projects when the student lacks a mature base in any of the contributing disciplines" (p.3).
Yet with such a disciplinary focus, Chan (2004) reports that prospective teachers in particular are influenced heavily by *epistemological loyalty* and become reluctant to engage with other disciplines. Spalding (2002) concurs saying that some teachers "base their professional identity not in teaching, but in the teaching of their subject" (p.700). Teachers may only be motivated to teach in their subjects, which Spalding (2002) claims can present a barrier to interdisciplinary instruction. This disciplinary focus plays a big role in the confidence and professional practice of teachers, with Beudels et al. (2021) claiming that "if a teacher does not feel competent in a particular domain, he/she will tend to avoid topics from that area in class" (p.745). They found

that teachers' confidence levels in subjects, or lack thereof, influences how well they teach disciplines or across disciplines. Christensen & Toverud Godø (2021) explain this as the "teacher's understanding of their own core competence" (p.17). While Oliveira et al.(2017) question the extent of disciplinary content knowledge a teacher needs, there are many studies which confirm that a development of content knowledge leads to a growth of confidence and motivation for subjects which they have previously shied away from (Beudels et al., 2021; An, 2016; Hammond & McCallum, 2009; Hayes, 2009; Spalding, 2002; Andrade et al. 1999; Kaufman & Grennon Brooks, 1996). It is not only necessary to increase a teacher's content knowledge within other disciplines, but it is necessary to develop interdisciplinary knowledge and understanding. According to Kang and Keinonen (2016), familiarisation will increase teacher confidence and make them more likely to actively engage with the implementation of a new pedagogical strategy.

Knowledge of Interdisciplinarity

Interdisciplinary teaching is only possible when a teacher is aware of the different components of their own discipline and is able to use and communicate them in another context (Harnow Klausen, 2014). This is known as *interdisciplinary synthesis*, which according to Parker et al.(2012) and Stein, Connell & Gardner (2008), is one of the most difficult things for humans to master. There are expectations that teachers can simply conduct this synthesis, yet Parker et al. (2012) and Venville et al. (2002) found this is not the case. This implies that both disciplinary knowledge and an understanding of interdisciplinarity are needed.

Interdisciplinary thinking and knowledge involves "knowing what interdisciplinarity is, and how to differentiate between multi-, inter- and transdisciplinary approaches and when to use them" (Spelt et al., 2009 p.373). In their study, Parker et al. (2012) found that while prospective teachers were positive to interdisciplinary teaching, they lacked clarity when it comes to defining interdisciplinarity and creating goals for its' implementation. This was also found by Paulsen Dagsland (2022) in her study of practicing teachers. In both studies, their definitions were predominantly based around the idea that the subjects "melt" or are integrated into one another. While they presented an understanding of interdisciplinarity, how it was interpreted and implemented in their professional practice was different. In addition, each teacher approached interdisciplinarity differently from one another (Paulsen Dagsland, 2022). In both studies, the majority of informants expressed they had little experience with interdisciplinarity,

and as such may be considered to be expressing opinions in a discourse with which they are unfamiliar.

In Brazil, Fidalgo-Neto et al. (2013) found that teachers were over-confident in reporting their interdisciplinary knowledge and practices, which led the authors to conclude that teachers lack the support and competence to develop interdisciplinary approaches in the classroom and advocate for more interdisciplinarity in teacher education. Theo Koritzinsky (2021) makes similar claims, stating that Norwegian teacher education needs to prioritise interdisciplinary teaching, which will provide prospective teachers the necessary tools to take out to schools. Boix-Mansilla, Miller and Gardner (2000) describe interdisciplinary competence as "the capacity to integrate knowledge and modes of thinking in two or more disciplines or established areas of expertise" (p.17). Again, this implies a requirement of diverse disciplinary content knowledge, but furthermore this quote speaks of *modes of thinking*, involving a deeper understanding of disciplinary methodology and epistemology to a degree that communication and collaboration is possible.

Communication & Collaboration Skills

As previously presented, interdisciplinarity requires the development and utilisation of critical life skills such as, communication, teamwork, reflection and evaluation (Xu et al. 2022). These may appear to be skills which are also necessary in disciplinary project-work, however, communication within a discipline is considered simpler, as professionals share a common language, methodology and generally similar understandings of a concept (Jacobs, 2017; Klein, 1990). Interdisciplinary work in contrast, requires the ability to communicate and ask questions across disciplinary boundaries. This is illustrated in an interview with Gombrich & Hogan (2017) where an informant said,

> *Sometimes people speak the English language, but they can't speak the same academic language... You can see that interdisciplinarity means you learn the language of both, and you are a bridge. You connect the two together, and that, I think, is a way which will change the way that people work.* (pp.552-553).

Kaufman and Grennon Brooks (1996), in a rare intervention across the humanities and sciences, found that interdisciplinary communication was easier after their intervention, yet studies by Xu et al. (2022) and Björkgren, Gulli & Hilli (2014) indicate that both defining

interdisciplinarity and engaging in interdisciplinary communication was still a struggle for their participants post-intervention. However, it is claimed by Soares et al. (2013) that curriculum designers frequently underestimate the challenges of an interdisciplinary curriculum, therefore empirical studies based on one intervention, such as those mentioned above, may not be indicative of the potential impact of interdisciplinary skill development. However, Xu et al.(2022) found a considerable lack of effort and motivation on behalf of the students, which they perceived as negatively influenced their intervention. Their students rebelled against interdisciplinary practices and expressed distrust for teachers of other disciplines, creating significant obstacles for innovative collaboration which indicates a need for further engagement with interdisciplinarity and reflecting upon other disciplines.

Reflection & Critical Reflection Skills

In a study by Schjif et al. (2022) they found that tertiary students still preferred to collaborate with their friends, or with those who have similar disciplinary backgrounds, therefore they consider reflective skills as essential for innovation and effective communication amongst colleagues. Spelt et al. (2009) claim that for successful interdisciplinary work, reflection is "essential to stimulate students to depart from their notion of absolute knowledge" (p.373) something which is ingrained in disciplinary epistemologies. Both Spelt et al. (2009) and Lattuca et al. (2004) claim that provoking students to utilise contrasting and conflicting disciplinary perspectives helps them to develop critical reflective skills.

A study by Parker et al. (2012), measured prospective teachers' perceptions before and after an interdisciplinary intervention. The participants came with more critically reflective perspectives of interdisciplinarity after reflecting on their experiences. Initially, they pointed out that interdisciplinarity could be motivating, beneficial for pupils' learning and connect to real-life. However, upon reflection they expressed concerns about meeting subject objectives, tensions between subjects and more time and resources needed to plan in an interdisciplinary manner. In this case, reflection led to more critical attitudes towards interdisciplinarity, as opposed to openness. This may be considered detrimental to its' implementation, as openness is one of the characteristics considered necessary to enable interdisciplinary work (Gombrich and Hogan, 2017). The informants in Gombrich and Hogan's study (2017) also claimed that *critical creativity* is needed, as opposed to the traditional educational skills of transmission and

acquisition, which most prospective teachers have experienced in their own schooling (Parker et al. 2012).

2.5.2. Student Characteristics

Personal Characteristics

Spelt et al. (2009) found that there are two sets of criteria relating to the student which influence interdisciplinary practices and thinking: *Personal Characteristics* and *Prior Experiences.* Three of the personal characteristics conducive to interdisciplinarity are curiosity, respect and openness which Spelt et al. (2009) claim "point at the necessary appreciative attitude towards other disciplines" (p.373). As mentioned, these characteristics were lacking in the Xu et al.(2022) study, and as a result, was not successful in raising interdisciplinary competence. Rita Borromeo Ferri (2016), in her work on Interdisciplinary Mathematics Education, elaborates on these characteristics saying,

> *We need teachers, who are open-minded enough not to see only their own favoured subject, or discipline, but who like to connect several disciplines, discuss their links with colleagues, create ideas, and make interdisciplinary teaching, and learning lively and motivating for their students* (p.260).

This quote illustrates that not only do teachers need to be familiar with disciplines, but they also need to be open-minded and willing to try new ideas and collaborations. Interdisciplinary work by definition requires blurrier subject borders and working together "to produce a cognitive advancement - such as explaining a phenomenon, solving a problem, or creating a product - in ways that would have been impossible or unlikely through single disciplinary means" (Boix-Mansilla, Miller & Gardner, 2000 p.17). This definition lends itself to a problem-based pedagogy, as advocated by Mebert et al.(2020) and Stentoft (2017). Teaching across disciplines does not necessary only mean linking single-subject competencies to a common theme, but engaging students (or pupils) in problem-solving scenarios which connect to their real-life experiences (Mebert et al., 2020; Stentoft, 2017).

Prior Experiences

The category *prior experiences* relates to the learning situations that prospective teachers experienced previously. Spelt et al. (2009) found that prior experiences influenced thinking and opinions relating to interdisciplinary teaching and learning. This is important to consider

in teacher education, where only a few prospective teachers reported significant experience with interdisciplinarity in their prior schooling (Parker et al., 2012). This may imply that extra effort is required in teacher education, where implementing interdisciplinarity may involve challenging existing beliefs and philosophies. Grossman (1991) explains that teachers often teach how they have learned in their schooling, and as such, teacher education programs may be required to *overcorrect* and challenge existing beliefs and philosophies "if professional courses are to foster innovative practices" (p.350). Meanwhile, Kaufman & Grennon Brooks (1996) claim that without interdisciplinarity being presented in teacher education, "it is unrealistic to expect that teachers will initiate such settings in schools" (p.233).

When interdisciplinarity is introduced as part of a teacher education program, it does appear to have positive effects on prospective teachers (Santaolalla et al. 2020; Hammond & McCallum, 2009; Spalding, 2002; Kaufman & Grennon Brooks, 1996). In a longitudinal study over several cohorts, Kaufman & Grennon Brooks (1996) found that students' perspectives had changed as a result of their interdisciplinary learning experiences in university, with one prospective teacher reporting they were no longer afraid of the "ominous topic of science" (p.240). This was replicated by Santaolella et al. (2020), Hammond and McCallum (2009) and Spalding (2002), and who found that prospective teachers could plan and implement interdisciplinary sessions and felt positive about the experience. It is important to note that the students' perspectives of interdisciplinarity in both studies were not measured prior to the interventions, however on the basis of these findings, gaining familiarity with interdisciplinary methods and working with unfamiliar subjects seem to raise the probability of interdisciplinary practices being implemented in schools. One study by Hammond & McCallum (2009) followed prospective teachers into practice, interviewing them one year after their participation in an interdisciplinary program. They found that all the informants had attempted to integrate interdisciplinarity into their teaching and "flourished as designers of [interdisciplinary] curriculum" (p.50). While it is difficult to alter the personality characteristics of prospective teachers, interdisciplinary experiences in university appear to promote open-mindedness, curiosity and respect for other disciplines and encourage the implementation of interdisciplinarity in schools.

The Norwegian Context

A lack of experience appears to influence the open-mindedness of Norwegian teachers, with Sinnes and Jegstad (2011) discovering that there was little engagement amongst colleagues to

work in an interdisciplinary manner (see also Sinnes and Straume, 2017). In some cases, teachers did not understand the purpose of interdisciplinarity, therefore very little changed in their pedagogical practice (Fostervold Bakken, 2021). On the contrary, there are some positive attitudes towards interdisciplinarity, with Rikardsen Jaatun (2022) finding that teachers were motivated to work across disciplines, however they were more motivated for an intra- or multidisciplinary approach, rather than an interdisciplinary one. Her study, like those of Bae Solvang (2021) and Hansen (2020) found that while teachers were open to interdisciplinarity they still felt they needed more professional development in this area. Paulsen Dagsland (2022) mapped teachers' prior experiences with interdisciplinarity, focusing on collaboration between Science and Creative Arts (kunst og håndverk). She found that most of the participants claimed that they had no or limited experience with interdisciplinarity between these subjects, as a result they generally found it "difficult to achieve those interdisciplinary things" (translated from p.38).

All of these studies indicate a variety of attitudes and competencies which prospective teachers meet out in praxis schools. Despite this, Rakel Rohde Næss, the head of the professional body for education believes that Norwegian teachers take the challenge of the new curriculum seriously, however she acknowledges it will take considerable time and effort on behalf of teacher educators, teachers and school leaders. She believes that teachers need to learn interdisciplinary teaching and learning through experience in their own teacher education, and out in praxis (Koritzinsky, 2021).

2.5.3. Learning Environment

Spelt et al. (2009) use Biggs' (1996) description of the learning environment focusing on four categories: curriculum, teachers, pedagogy and assessment. This thesis does not address the assessment of interdisciplinary teaching, instead focusing on the structure of educational institutions, development of curriculum, teacher attitudes and pedagogy needed to successfully implement an interdisciplinary approach in teacher education.

Structure of Educational Institutions

Planning a curriculum to include interdisciplinarity can be challenging for a tertiary institution, primarily structured by disciplines (Turner et al, 2017). According to Klein (1990) in the early 19th century, Wilhelm von Humboldt at the University of Berlin focused again on the fragmentation of knowledge and proposed a concept of universal education. However, he faced

difficulties due to the structural organization of universities, politics of disciplines and "criticisms directed towards whether such a unity of knowledge was possible or advisable" (p.22). These criticisms have been consistently valid, with the CERI Report (1972) stating that to "meddle with the disciplines means to meddle with the social structure of the university in its entirety (p.9). Introducing interdisciplinarity into the tertiary educational system is complicated according to Klein (2006), as two educational systems are trying to function at once; "an older system of subject structures holds fast, while a new one struggles into being" (p.16).

In the Czech Republic, Vasutova (1999) claimed that attempts to introduce interdisciplinarity into teacher education were negatively impacted by "the ideology of the past" (p.208). This is echoed by Santaolella et al. (2020) in Spain, who claim that universities which attempt to introduce interdisciplinarity are challenged by the structure of the educational system. They propose that that teacher education is too compartmentalised and disconnected with monodisciplinary instruction acting as “a barrier when it comes to promoting an interdisciplinary focus in their classrooms" (p.3).

In Norway, prospective elementary teachers have been limited to focusing on two specializations, perhaps three, as opposed to being educated in all subjects (Kulbrandstad & Kulbrandstad, 2022), with a reduced focus on interdisciplinarity (Aakre, 2022). However, in many countries, such as Australia, primary teachers are taught as generalists, expected to teach many content areas (Beudels et al. 2021), counteracting the monodisciplinary instruction Santaolella et al. (2020) report. The subjects are usually taught in isolation, focusing on one subject, with different percentages of time allocated to each subject (Collins, 2016). However, there are some universities attempting to develop and implement interdisciplinary curriculums, both outside and within teacher education (see for example, Gombrich and Hogan, 2017).

Interdisciplinary Curriculum

As previously presented, interdisciplinarity is touted as a method for creating innovative solutions to universal, complex problems (LeFever, 2008; Boix Mansilla, 2005; Deneme & Ada, 2012). One such problem is *globalization* which has inspired interdisciplinary curriculums at institutions in Spain, the UK, Finland, the US and Australia. (Santaolella et al. 2020; Gombrich & Hogan, 2017; Björkgren, Gullberg & Hilli, 2014; Dentith et al. 2011; Hammond & McCallum, 2009; Spalding, 2002; Kaufman & Grennon Brooks, 1996). Two

programs, one by Gombrich & Hogan (2017) and Dentith et al. (2011), are not teacher education programs, but they are presented here for two reasons. Firstly, they both cross the constructed divide between the sciences and the humanities and have specific courses relating to interdisciplinary themes, similar to those in the Norwegian curriculum. Secondly, they focus on holistic development of the individual throughout the program of study, as opposed to an interdisciplinary intervention in a single subject.

In the UK, the Bachelor of Arts and Science at the University College of London is claimed by Gombrich & Hogan (2017) as "arguably the first major initiative in interdisciplinary undergraduate education in the UK this century" (p.545). Undergraduates are required to cross the constructed divide between the arts and sciences, which Gombrich and Hogan (2017) feel is "positively discouraged in some circles" (p.546). In addition to crossing this divide, students are required to learn both quantitative and qualitative methods of research as well as modules on interdisciplinarity and *interdisciplinary research,* which appears to be unique. There are interdisciplinary electives for the students to choose from, such as "Migration & Health", "Technology, Heritage & Material Culture" and "Understanding Cities" (p.547). Gombrich & Hogan reported that graduates of the program were high achievers, well-placed in the job market and in academia, which they attributed to the development of 21st century skills necessary for collaborative, innovative work.

Dentith et al. (2011) developed two interdisciplinary undergraduate programs at a large Southern U.S. University. They created five inquiry-based core courses integrating science, math, social issues, humanities, literature, art and history. They describe their process of creating an interdisciplinary curriculum as "an exhilarating, albeit complex cross-disciplinary process" (p.78). Their five courses entitled; "Society & Social Issues", "Science & Humanity", "Culture, Literature & the Fine Arts", "Diversity, Equity & the Social Sciences", and "Interdisciplinary Inquiry", each have a focus on reflective practice and sustained inquiry into global issues. The program has a heavy autobiographical focus, aimed at students developing their own understandings, something which they consider "a central component in the journey toward becoming global individuals" (p.81). The program was considered so successful that it has become a requirement for all Education majors.

In teacher education, a majority of the studies focus on the results of one intervention, for example, Xu et al., (2022), Santaolalla et al. (2020), Mestrinho & Cavadas (2018), An (2016), and Spalding (2002), however the longitudinal study of Hammond & McCallum (2009) from

Australia appears unique. It focuses firstly on the development of a teacher education program, with three interdisciplinary courses focusing on universal and complex problems, and secondly, on how the new graduates implemented interdisciplinarity in their professional practice. Like the Norwegian school curriculum, it is focused on "three core values of sustainability, social justice and democratic process" (p.53). While their program was a success, Hammond & McCallum (2009) acknowledge that creating their interdisciplinary courses involved "deep levels of collaboration and commitment to realise the ideal of interdisciplinarity" (p.54), with both Dentith et al. (2011) and Hammond & McCallum claiming that motivated faculty is essential for the successful implementation of an interdisciplinary curriculum.

Teachers

Designing an interdisciplinary curriculum is not easy, as it crosses traditional disciplinary boundaries and weakens the integrity of individual disciplines, which may cause resistance from institutions and faculty (Dentith et al. 2011; Hammond & McCallum, 2009; Bernstein, 1996). Boix Mansilla (2005) found that a lack of clear pedagogy, language and conceptual framework made faculty reluctant to engage with interdisciplinary programming. Dentith et al. (2011) found that their initial attempt to implement an interdisciplinary project failed after the program leader retired. The drive and enthusiasm dwindled for a long period of time. After the project's resurrection some years later, the authors cited many difficulties:

> *too little time, few rewards or incentives for collaborative program work, and an expert model that favours subject-centred disciplinary approaches are some of the obstacles to this work. Taking the time to develop courses in an interdisciplinary program of study proved challenging at times.*
>
> Dentith et al., 2011 p.81

Motivation is not the only factor influencing curricular development. Having sufficient time for collaboration is also a significant factor, particularly when a program is divided. Norwegian teacher education at university is divided into two, pedagogy and subject-didactics (fagdidaktikk). All prospective teachers are required to take pedagogy, while subject specializations occur in subject-didactics courses (Kulbrandstad & Kulbrandstad, 2022). In the Norwegian context, Karen Hammerness (2013) conducted a study of Norwegian teacher education and found divisions between pedagogy and subject-didactics courses. She found that

teachers of pedagogical subjects were more focused on schools, while those responsible for subject specializations were "focused upon their subjects" (p.410), rather than developing a pedagogy which closely connects theory to praxis.

Pedagogy

It is important that theory presented at university is coherent with the practice experienced in schools, with the same intents, purposes, and goals (Hammerness, 2013; Grossman et al., 2008; Darling-Hammond et al., 2005). Hammerness (2013) also claims that prospective teachers cannot learn an ambitious teaching practice (such as interdisciplinarity), in praxis alone, and this must be reinforced in university. In all its' complexity, interdisciplinarity needs explicit teaching of didactics (Borromeo Ferri, 2016) something which Hammerness (2013) found that Norwegian universities were reluctant to do, stating they are “sceptical about introducing new teachers to any particular teaching strategies” (p.412), preferring to relegate the practical aspects of teaching to praxis schools.

However, the new emphasis on interdisciplinarity in the curriculum may mean that "the new teacher may sometimes know more than the mentor about new teaching strategies" (Hargreaves and Fullan, 2000 p.53). This could possibly mean that prospective teachers may not receive sufficient guidance. This was experienced by the informants in a study by Ryu et al. (2018). They perceived that their praxis teachers had a limited interdisciplinary understanding and claimed that this lack of adequate role models would inhibit them from implementing interdisciplinarity in their own practice. This may be partially counteracted by prospective teachers having interdisciplinary experiences in university, however Hammond & McCallum (2009) found that their graduates, despite eagerly introducing an interdisciplinary approach, had a variety of experiences with their colleagues. Most of them reported positivity and support however some of them were left isolated and feeling alone. According to Lieberman (1995), teacher isolation has been identified as the biggest hindrance to the implementation of curriculum reform (in Sandholtz, 2000). Therefore, it may be considered insufficient that only prospective teachers are taught about interdisciplinarity, but that practicing teachers also receive professional development to develop their own interdisciplinary understanding and skills to be appropriate mentors (Ryu, 2018).

2.6. Conclusion

Despite the ambiguity of interdisciplinarity in terms of definition and discourse, it is an approach adopted by many countries today, on a quest for innovation and development of 21st century skills (Frodeman, 2017; Gombrich & Hogan, 2017). It is unrealistic to expect teachers who are unfamiliar with interdisciplinarity to implement it in schools, thus it is important that interdisciplinarity is incorporated into teacher education (Kaufman & Grennon Brooks, 1996). It is important that teacher educators provide prospective teachers with quality experiences and opportunities as "pupil achievement depends to a large extent on skills and practices of K-12 teachers and teachers depend on the preparation they receive from teacher education" (Goubeaurd & Wenfan, 2004 in LeFever, 2008 p.13). This poses challenges for the faculty of teacher education to facilitate such educational experiences with Dentith et al.(2011) and Hammond and McCallum (2009) citing difficulties with motivated faculty and the disciplinary structures of the university. In terms of teacher education, it is additionally complicated when it comes to creating coherent theoretical work in university to experiences in praxis (Hammerness, 2013).

There appears to be little evidence relating to prospective teachers experiences with interdisciplinarity in teacher education (Biseth et al., 2022). However, based on the theories of Hammerness (2013) and Grossman (2008) who claim that universities relegate didactics to praxis, this study poses a tentative hypothesis that interdisciplinary experiences for prospective teachers occurs more in praxis than in university. However, as the study by Ryu et al.(2018) indicates, these praxis experiences may be of low quality due to a lack of experience and confidence of praxis teachers (Parker et al. 2012; Meister & Nolan, 2001). This last point has heavily influenced the choice of study design, opting for a mixed methods approach.

3.0 Study Design

Given the ambiguity and complexity surrounding the interdisciplinary discourse and current evidence from the Norwegian context as presented in the literature section, it was considered appropriate to take a mixed-methods approach. While the quantitative component can provide an indication of the number of experiences many prospective teachers have, the qualitative interviews can provide insight as to the nature of these experiences in university and in praxis schools. The qualitative data may also provide explanations for the quantitative results. Growing interdisciplinary interest to address complex problems has led to the increasing

development of mixed-methods research (Creswell and Plano Clark, 2007 p.18). Mixed-methods research "involves collecting, analysing, and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon" (Leech and Onwuegbuzie, 2008 p.265). The problem of implementing interdisciplinarity in education is complex, requiring focus on both experiences and perceptions of prospective teachers across two different settings: university and praxis. This is a cross-sectional study, focusing on the perceptions of student teachers at one point in time (Simkus, 2023). The quantitative data was collected through an electronic survey, whilst the qualitative data collected through semi-structured interviews.

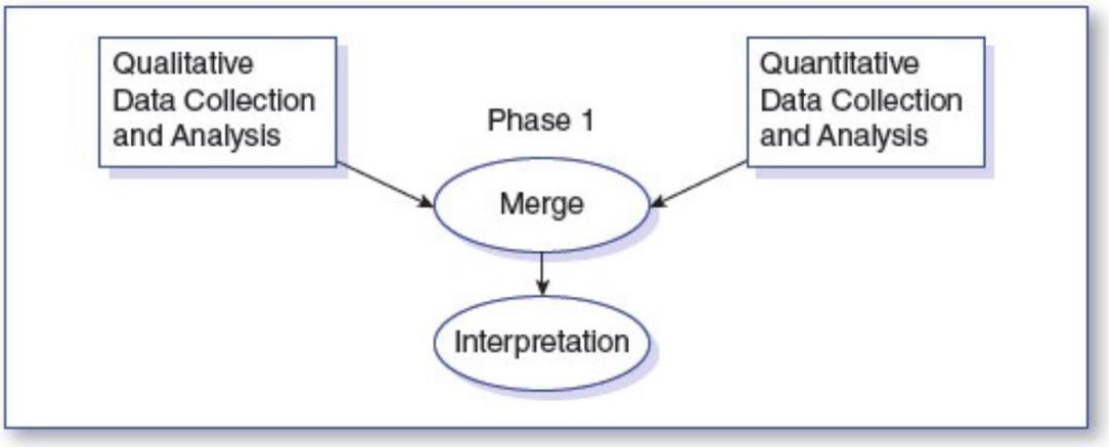
This project utilizes the Convergent Mixed Methods model presented in Figure 2. The Convergent design involves collecting both sets of quantitative and qualitative data at the same time and analysing them separately before merging and interpreting the results (Creswell & Plano Clark, 2011). While the main point of interface linking the datasets will occur in the results and discussion sections the design of both quantitative and qualitative instruments has been done with the intention of *triangulating* the data. In convergent designs it is important that both data sets are weighted equally and considered equally valid (Creswell, 2018). However, the nature of each research question is different, therefore this study will be taking a convergent, but nested approach (Bronstein & Kovacs, 2013). Question one focuses on prospective teachers' perceptions of interdisciplinarity, therefore it will take a QUAL + quant approach. Question two focuses on the number and nature of experiences with interdisciplinarity and will take a QUANT + qual approach. One disadvantage of this design that that if the data is not convergent, it requires further analysis, or in the worst case, be thrown out (Frederiksen, 2020). However, *convergent validity* may provide more secure knowledge and "multi-faceted descriptions" than using a single research method on its' own (Frederiksen, 2020 pp.262-263).

3.1. Research Paradigm

This research project will be positioned within the Pragmatist paradigm pioneered by Charles Sanders Peirce (1839–1914). Early pragmatists rejected the notion that "social inquiry using a single scientific method could access truths regarding the real world" (Weaver, 2018 p.1287). Pragmatism is flexible in terms of ontology and epistemology, seeing truth as something that functions at a particular point in time with reality being actively created by individuals and

Figure 2

Convergent Mixed-Methods Model



oriented towards solving problems (Weaver, 2018; Creswell et al., 2018). This problem-solving focus impacts the methodology, with pragmatists exploring different methods rather than one specific method (Creswell and Creswell, 2018). Due to this, pragmatism "has gained considerable support as a stance for mixed methods research" (Weaver, 2018 p.1287).

Peirce was also a pioneer of the abductive approach, claiming that pragmatism is the "logic of abduction" (1931, p.196). Abduction focuses on using the data one has at hand, which is often incomplete, to come to probable conclusions (Mitchell, 2018). An abductive standpoint can be used to make discoveries and generate new ideas, or tentative theory, with a focus on the intuition of the hypothesis and allowing for "the possibility of creation of new elements that produce a new assessment of coherence" (Thagard & Cameron, 1997 §5). It can be difficult to differentiate abduction from induction and deduction. Chong (1994) summarises by saying, "as abduction creates, deduction explicates, and induction verifies" (p.24). Abduction generalises based on the interactions between the specific and the general (Dudovskiy, 2016 in Mitchell, 2018), which make it suitable for mixed methods research. Due to the unique nature of this study which studies two different settings in teacher education, both the quantitative and qualitative methods of data collection and analysis will employ an abductive approach, moving between deductive and inductive phases of inquiry to generate probable conclusions and future hypotheses for investigation. This study is explorative, something which Chong (1994) claims fits well with the "logic of abduction" (p.1). While abduction is a relatively newer standpoint which researchers can be discouraged from taking, this thesis does not aim to deductively prove a theory, or to verify prior research or "hunch". Mitchell (2018) states that "abductive reasoning, follows a pragmatist perspective, taking incomplete (or 'messy') observations from

experience and reality that may then lead to a best prediction of the truth" (p.105), which is the aim of this thesis.

3.2. Population & Sample Group

This study utilises a single sample group for quantitative and qualitative data, with the entire sample participating in the quantitative with a sub-set for the qualitative data collection (Bronstein & Kovacs, 2013). This study was conducted at one university spanning two teacher education programs, primary and middle school known as “grunnskolelærerutdanning” (GLU). Prospective teachers taking the primary program specialise in grades 1 - 7, while the middle school specialises in grades 5 - 10. This university and programs were chosen as part of a bigger ongoing study comparing three teacher education programmes. The sample groups in this study were accessible due to a praxis period undertaken within GLU. The total population in both programs is 863 students. Two study years were strategically selected , second (N=88) and fifth years (N=166), referred to as 2GLU and 5GLU respectively, totalling two hundred and fifty-four students. These clustered sample groups were selected as they have both pedagogy and subject-specialization subjects in the current year of study. The first-year students were excluded, because of their limited experience within the program. All students in 2GLU are taking the program 5 – 10, while in 5GLU there is an even split between the programs (N=83).

In a convergent mixed-methods design, the sample groups stem from the same population, often utilising a *sub-set*, a smaller sample stemming from the main sample group (Bronstein & Kovacs, 2013). Frequently the sample sizes for quantitative data are larger than the qualitative data, due to time constraints, willing participants and available team members to analyse the data (Creswell, 2015). They may also be different due to the differing purposes of quantitative and qualitative data, where qualitative data looks to go deeper with fewer informants, whilst quantitative data looks to generalise to a population (Brinkmann & Tanggaard, 2020).

After the survey was administered, the respondents were asked to volunteer for a follow-up interview. Two students from 2GLU took contact via email, and one recruited her friend. For the 5GLU informants the teachers were asked for likely candidates and these were contacted via email. All in all, seven informants from GLU were recruited, three from 2GLU and four from 5GLU. The three participants from 2GLU comprised of two females and one male. From 5GLU there were two male participants and two females. The students were taking a variety

of subject specializations: Norwegian, English, Religion and Ethics (KRLE), Physical Education, Food and Health, Science and Mathematics. Two of the participants had specialized in Special Education. Most students specialized in two subjects (60 credits each), with several of the participants having three (30 credits). Sample group demographics (with names anonymized) are presented in Table 1. The informants had different levels of experience in schools, with some having only been on two rounds of praxis, meanwhile some of the participants in 5GLU had current temporary positions or had been working casually in schools for several years.

Table 1

Sample Group Demographics for Qualitative Interviews

Informant	***Gender***	***Year Group***	***Subject Specializations***
Loke	Male	2GLU	Science and English
Sara	Female	2GLU	KRLE (Religion and Ethics) and English
Sunniva	Female	2GLU	Norwegian and Physical Education
Louise	Female	5GLU	Norwegian, KRLE, Food and Health (30sp)
Finn	Male	5GLU	Norwegian, Humanities, Special Ed. (30sp)
Diana	Female	5GLU	Norwegian, Religion, Food and Health (30sp)
Aslak	Male	5GLU	Norwegian, Humanities, Special Ed. (30sp)

4.0. Ethics

The research proposal, including survey and interview guide were both sent to the Norwegian Centre for Research Data (NSD) for approval. The National Committee for Research Ethics in the Social Sciences and the Humanities (NESH) and APA7 guidelines for research were reviewed prior to the administration of the survey and conducting of the interviews. The participants for the survey were informed of their right to not participate and assured of their anonymity. The informants were given a consent form to sign, which described the project, how the data would be used, stored and deleted at the completion of the project. The informants were assured of their anonymity and care was taken to anonymise data as much as possible,

with aliases given to each of the informants. The informants were offered a transcription/summary of their interview, which none of the informants requested. The NSD approval and consent form are in Appendix A.

5.0. Quantitative Method

Quantitative research enables the researcher to collect information on a broad range of experiences and observe general connections in the data (Foldnes et.al, 2018). This may be especially useful when examining interdisciplinary experiences in praxis, collecting data from a more diverse range of praxis schools.

5.1. Instrument Development

The quantitative method comprised of an electronic survey divided into two sections, coherence and interdisciplinarity. The coherence (CATE) survey is a well-established and has been used in many countries including Norway, Finland, the US, Cuba, Chile and Malaysia (Swee Choo Goh et al. 2020; Canrinus et al. 2019; Canrinus et al., 2017; Hammerness and Klette, 2015). This section was included as part of a larger ongoing study spanning differing teacher education programs at the university being studied (Canrinus et al., ongoing). The original plan for this master thesis was to see if there was a correlation between perceived coherence and experienced interdisciplinarity, yet these analyses were outside of the scope of this paper. However, this is an additional reason the questionnaires were combined together.

As no established survey regarding interdisciplinary perceptions and experiences in teacher education was found at the time of data collection, a researcher-developed section was included in the survey. There were two overarching constructs to be evaluated: *external student experiences* and *internal student beliefs*. Questions in the quantitative survey were both deductive and inductively created. While one may question if a quantitative survey can be inductive, in their meta-analysis of survey development from 1975 – 2015, Morgado et al. (2017) claim that "initial item generation can be classified as deductive, inductive, or a combination of the two" (p.1). The *experiences* portion of the survey was deductive, based on the ideas of Darling-Hammond et al.(2005) who claim that student teachers need explicit, repeated teaching of relevant pedagogical strategies and coherence between theory and praxis. This was operationalized by using the terms, *observe, plan, teach* and *reflect*, inspired by the Action Research Cycle of Kemmis and McTaggart (1988) and the theory of teacher identity

development of Nazari (2022). These were chosen due to their close alignment with daily reflective-professional teaching practice.

The *beliefs* section of the survey was more inductive, with item and construct development being "based on qualitative information regarding a construct obtained from opinions gathered from the target population" (Morgado et al., 2017 p.1). While the researcher presents ideas or statements for the participants to think about, this portion contained a broad range of questions designed to hear participants' opinions and beliefs to see if any inductive patterns emerge from the data. The open-ended variable allowed for the respondents to provide further or different information. Quantitative survey analysis also involves an inductive approach, with Kahlke et al., (2023) stating that, "quantitative researchers often do a bit of inductive reasoning to find meaning in data that hold surprises" (p.18).

The survey consisted of six constructs: University, Praxis, Curriculum, Confidence, Beliefs and Relevance. The constructs, *University* and *Praxis* were designed to find out how much opportunity student teachers felt they have had to engage with interdisciplinarity, and to compare what is experienced in university and in praxis. These intended scales had four items each: opportunities to observe, plan, teach and reflect upon interdisciplinary teaching. The constructs *Curriculum* and *Confidence* comprised of four variables each. They aimed to measure students' perceptions of coherence between teacher education and professional practice in three ways: how much opportunity they have had to become familiar with the overall and interdisciplinary aspects of the curriculum, how confident they feel in teaching within and outside their subject specializations and thirdly, how confident they feel using the interdisciplinary themes in their teaching. The construct, *Beliefs* comprised of six individual items designed to gain more insight on prospective teacher beliefs and aims based regarding interdisciplinarity. A question relating to the relationship between interdisciplinarity and deep learning was included for two reasons. Firstly, the two concepts have both been introduced into LK20 at the same time, with interdisciplinarity being promoted as the vehicle for deep learning (Bolstad, 2020), a claim which is frequently debated (Xu et al.2022; Winje & Løndal, 2020). Secondly, based on the monotony and simplicity of definitions provided by informants in the literature (Paulsen Dagsland, 2022; Parker et al., 2012), it was also considered that this variable may provide more insight regarding the participants' beliefs and values regarding interdisciplinarity. There were three questions relating to the perceived relevance of pedagogy, subject didactics and praxis, based off of conversations had in 5GLU. However, these were not

relevant for interdisciplinarity and were removed from the analysis. There was an open-ended section where students could expand upon their answers or to comment on a particular aspect of the program. In total there were fifty items: eighteen on coherence, twenty-five on interdisciplinarity, three demographic items, three relevance items and one string variable. The number of items for each construct and sample items are in Table 2. Four-point Likert scales were used in coherence with the CATE portion of the survey. There were two different answer categories, agree/disagree and no opportunity/lots of opportunity. The four points on the Likert scale ranged from: 1 = *Strongly disagree/No opportunity*, 2 = *Disagree/Limited opportunity*, 3 = *Agree/Some opportunity*, 4 = *Strongly Agree/Lots of opportunity.* The survey is presented in Appendix B.

5.2. Pre-Survey Administration

After the development of the survey, a pilot study was run to ensure construct validity and to avoid participant fatigue. The completion time was tested to ensure that it would not be too long for participants, making them less likely to complete the survey. Saleh and Bista (2017) cite studies by Asiu, Antone, & Fultz, (1998) and Handwreck, Carson, & Blackwell (2000) who found that surveys under thirteen minutes were likely to have higher completion rates. In the pilot study, the survey took an average of seven minutes to complete. Frequent survey demands on students can also lead to survey fatigue. This may decrease the number of respondents, but also can reduce the validity of results, as participants may not complete the survey or not consider their responses carefully (Fass-Holmes, 2022). The students in GLU have not participated in many studies, and the surveys were administered as part of a teaching session which helped to ensure a high response rate. This means the data may be considered valid (Fass-Holmes, 2022).

5.3. Survey Administration

In both sample groups, the survey was presented in a formal lesson, explaining its intents and purposes and explaining to the students their right not to participate as outlined in the Ethics section. However, to increase completion rates, there were differences in how the survey was administered. 2GLU participated in the survey first and were allocated time at the end of a lecture. Due to a relatively low response rate, the survey link was placed on the digital learning platform, and students were encouraged to participate. The teachers decided that 2GLU would receive seminar time in the next week to complete the survey, but this did not occur. However,

the link remained open for one week after official administration and one more response was collected. 5GLU participated in the study at the beginning of a seminar. The seminar teachers and the researcher formally presented the survey, informing the students about the intentions of the survey and encouraging voluntary, full participation. The survey link was then activated, and the students were allocated enough time to complete the survey before the teaching commenced. After this time, the survey was closed to respondents and the link removed from the learning platform.

Table 2

Intended Scales and Sample Items Interdisciplinarity

Constructs	**Items**	**Sample item**
University	6	To what extent, have you been presented theory connected to interdisciplinary teaching and learning?
Teaching praxis	4	To what extent, have you been able to teach in an interdisciplinary manner in praxis?
Curriculum	5	To what extent, have you had the opportunity to become familiar with the three interdisciplinary themes?
Confidence	4	How confident would you feel teaching all subjects from grades 5 – 10?
Beliefs	6	I believe that subject boundaries are important to have.
Total Items	**25**	

5.4. Validity and Reliability

As the survey was conducted in Norwegian, two native speakers proof-read and took the survey to ensure that the language was clear and that the questions were not double-barrelled or ambiguous. This was a way to ensure content validity which "ensures that indicators tap into the meaning of a concept as defined by the researcher" (Drost, 2011 p.118). As Drost (2011) recommends, the survey was also presented to a research expert for guidance in the development and structuring of the survey items.

This survey is generalizable to specific target populations, namely students in teacher education programs. The interdisciplinary portion of the survey is written in a way which is transferrable and could be used to understand how any prospective teacher experiences interdisciplinarity in

university and praxis. According to Drost (2011), this is a form of external validity (p.120). Reliability will be addressed in the next section.

5.5. Data Preparation

There were one hundred and thirty-eight respondents to the survey. The overall gender distribution of respondents was 62% female (N =80) and 38.5% male (N=49), with one missing answer (N=1). The data from 2GLU and 5GLU was collated into Excel then imported into SPSS for analysis and cases with missing data were removed. In 2GLU there were thirty-six complete responses (eight removed due to incompletion) which resulted in a response rate of 41%.

In 5GLU, ninety-four participants completed the survey, resulting in an answer rate of approximately fifty-seven percent. There was no missing data in 5GLU. In total, one hundred and thirty responses were analysed, making an overall combined answer rate of forty-nine percent. This is higher than the average of 44.1% for electronic surveys reported by Wu (2022, p.1). The sample group demographics, response and completion rates are shown in Table 3. It should be noted due to the day and method of survey administration in 5GLU the response rate may be considered higher. It was administered prior to a long weekend and almost one-third of the classes were missing (104 students present of 166 total).

Table 3

Sample Group Demographics, Response and Completion Rates

Year	Number	Complete Responses	Response Rate	Incomplete
2GLU	88	36	41%	8
5GLU	166	94	57%	0
Total	254	130	49%	8

Principal Component Analysis (PCA) is a statistical procedure which summarizes data into a smaller set of variables for ease of analysis. It aims to increase the amount of variance explained using the least number of variables (Joliffe & Cadima, 2016). Because these items have not been used together to measure these constructs before, principal component analysis was used, in line with other studies (e.g., Canrinus et al., 2012). This study will focus primarily on the

interdisciplinary portion of the survey, although individual coherence items will be presented, due to their emergence in the qualitative data.

The PCA on the interdisciplinary section, revealed three major scales: *University* (21.14%), *Praxis* (11.47%) and *Curriculum* (8.93%) and three minor scales, *Subject Confidence* (7.08%), *Theme Confidence* (6.45%) *and Values* (5.40%) resulting in a total variance explained of 60.53%. The scales, sample items, variance explained, and internal consistencies are presented in Table 4. The reliability of each scale was calculated using Cronbach's Alpha and the Spearman-Brown coefficient. The Spearman-Brown coefficient was used on the minor scales which consisted of only two items. The scale reliabilities are all at an acceptable level, ranging from acceptable ($\propto = 0.705$) for Confidence (Themes) scale to excellent ($\propto = 0.904$) for the Praxis scale.

Before comparisons of scales and variables can be made, each scale or variable needs to be tested for normality using a Kolmogorov-Smirnov test. This test indicates if a scale has normal distribution. A significant deviance from normality (p=<.05) indicates a non-normal distribution (Foldnes et al., 2020). If a scale has normal distribution the means and parametric tests can be used for comparisons. Not normal distributions require the use of medians, interquartile ranges and non-parametric tests. None of the scales demonstrated normal distribution (University p=0.005, all others, p=<.001).

5.6. Data Analysis

This section outlines how each question will be analysed quantitatively and presented in the merged results.

RQ 1: How do prospective teachers perceive interdisciplinarity as a pedagogical approach?

All the individual items from the designed Beliefs section are used to answer RQ1. The individual items from the Beliefs portion of the survey were sorted into two groups, positive and negative. The negative variables were recoded prior to PCA. There are three variables in each group as indicated in Table 5. The descriptive statistics and frequency graphs will be presented for each variable.

Table 4

Scales, Variance Explained and Internal Consistencies

Scale Name	Items	Sample Item (translated)	Variance Explained	Internal Consistency
University	5	How much experience have you had in planning interdisciplinary teaching at university?	21.21%	∝ 0.806
Praxis	4	How much opportunity have you had to observe interdisciplinary teaching in praxis?	11.45%	∝ 0.904
Curriculum	6	How much opportunity have you had to become familiar with the three interdisciplinary themes	17.39%	∝ 0.724
Confidence (Subject)	2	How confident would you be teaching in all subjects from grades 5 - 10?	7.08%	∝ 0.758
Confidence (Themes)	2	How confident would you be connecting the interdisciplinary themes to your subjects?	6.45%	∝ 0.705
Beliefs	2	Interdisciplinarity is a goal in my teaching	5.40%	∝ 0.718
TOTAL	**21**	**Total variance explained**	**60.53%**	

Table 5

Belief Variables Positive and Negative.

Positive	***Negative***
Interdisciplinarity helps develop pupils' Bildung.	I think subject borders are good to have
I would feel comfortable teaching across subjects.	I only want to teach in my subject specializations
I have interdisciplinarity as a goal in my teaching	Deep learning is possible without interdisciplinarity.

RQ 2: To what extent and in which ways do prospective teachers experience interdisciplinarity in university & praxis?

For question 2a) and 2b), the items in the scales University, Praxis and Curriculum will be presented using descriptive statistics and frequency graphs. In question 2c) a paired Wilcoxon signed rank test was used to see if there is significant differences between the medians of these scales. Directional hypotheses were created:

H0: There will be no significant difference between experiences with interdisciplinarity in university and in praxis.

H1: Interdisciplinarity will be experienced significantly more in praxis than in university.

Three single items from the Coherence portion of the survey have been selected as the variables which closest relate to interdisciplinary teaching practices. The following variables will be presented using descriptive statistics and frequency graphs:

- I am met with the same ideas regarding teaching and learning across subjects.
- I experienced a clear connection between ideas and concepts across subjects
- The teachers who teach in teacher education explicitly referred to content and terms which appear in other subjects than their own.

The open-ended variable will be analysed by connecting student responses to the related questions. As the respondents were free to comment on any aspect within their education they felt relevant, all responses relating to the research questions will be reported and appropriately included in the merged analysis.

6.0 Qualitative Method

For the qualitative portion of this study, seven semi-structured interviews were conducted and analysed using Braun and Clarke's (2006) six-stage Thematic Analysis model. The interviews were designed to triangulate the quantitative results and to provide complementary or conflicting ideas and points of view (Frederiksen, 2020).

6.1. Interviewer Standpoint

From a constructivist standpoint, knowledge is co-constructed between the researcher and the interviewee with neutrality impossible to achieve (Lincoln, Lynham and Guba, 2011). However, attempts should be made to acknowledge a researcher's standpoint and to be able to "put their understandings in parentheses" (Jacobsen et al, 2020 p.288) and be open to new ideas. The researcher standpoint was complex, having four distinct roles at the time of data collection: being a student at the university in question, being a practicing teacher who works with interdisciplinary teaching and learning daily, being a praxis teacher within GLU and being a research assistant working on a larger project relating to coherence in teacher education. It was difficult to balance this insider/outsider perspective, yet, understanding from each of these standpoints allowed the researcher to be able to use informal observations within the interviews which may have made the informant more at ease and help to ingratiate the researcher to the informant (Fangen, 2020). For example, a principal who came and lectured in 5GLU, this experience was used as an introduction to an interview question. The more comfortable an informant is with a researcher, the more likely they are to be open and let the researcher in (Fangen, 2020). There is a power imbalance between the researcher and the participant which needs to be taken in consideration. While Fangen (2020) writes about power relationships in terms of ethnicity and social class, being a praxis teacher in GLU meant the researcher was in a position of power over the students. The students were reassured of their anonymity and that nothing they said could influence their grades in any way. The interview was semi-structured and presented as a conversation between two colleagues to try and negate any issues of power in the interview process.

6.2. Conducting of the Interviews

6.2.1. Pilot Interview

A pilot interview was conducted with a PhD candidate who had gone through a primary teaching education program. This was done to check the clarity of the questions, their order, and the length of the interview. The interview was intended to take an hour, which was reflected in the pilot interview, without the need to remove any questions. In this pilot interview it was pointed out that the way teacher education is constructed with the separation of subject didactics and pedagogy could be considered interdisciplinary as well, as opposed to only considering interdisciplinarity as the crossing of subject specializations. This idea was

integrated into the interview questions, as it added an additional dimension to experiences with interdisciplinarity in university. The students were asked about how pedagogy and subject didactics referred to one another and how closely they perceived that they were linked together.

6.2.2. Interview Process

As the interview was semi-structured, the order of questions was approximate, and the interview conducted as a conversation. Additional supplemental and clarifying questions were asked to ensure the researcher understood what the participant was trying to say. In each interview, the interviewer attempted to integrate a participant's area of interest, or subject specialization into the conversation to help put the participant at ease. The participants were reassured that if they were asked about their understanding of a term that it was not a test where they were expected to give textbook-style answers but try to give their personal understanding. The interviews took place in meeting rooms at the university, with the exception of one interview which was conducted over Zoom from the informant and researcher's homes. The interviews were all conducted in Norwegian, the mother tongue of the informants.

6.3. Interview Guide Development

The interview guide was developed to reflect the same constructs as the quantitative survey. This was done to aid triangulation of the data (Frederiksen, 2020), but also to see if any contradictions or new patterns emerge in the qualitative data. The interview guide followed the same format as the questionnaire; first focusing on experiences with interdisciplinarity in university and praxis and a discussion regarding the participants' beliefs and confidence with regards to interdisciplinary teaching and learning. A final portion of the interview asked the participants about any changes that they would like to see implemented in the teacher education program. While the questions were designed with the intention to triangulate the survey data, the questions were constructed to allow the informants to share their experiences, opinions, and new perspectives. While the interviewer focused on coherence and interdisciplinarity, the informants were not limited to these topics. The interview guide is in Appendix C.

Sample Question for Interdisciplinarity: To what extent do you think deep learning is possible without interdisciplinarity?

Sample Question Coherence: To what extent do your teachers in pedagogy refer to your subject specialization subjects?

7.0 Thematic Analysis

Thematic analysis is a common technique used for data analysis, yet it is frequently not credited as a stand-alone method. However, Braun & Clarke (2006) and Nowell et al. (2017) claim it should be, with Nowell et al. (2017) arguing that thematic analysis can be used "across a range of epistemologies and research questions. It is a method for identifying, analysing, organizing, describing, and reporting themes found within a data set" (p.2). Meanwhile, Braun & Clarke (2006) claim thematic analysis is useful to qualitatively analyse differing perspectives of participants as well as summarizing key features of a dataset. Thematic analysis is well-suited to mixed methods with Proudfoot (2022) claiming that, "the value of inductive/deductive hybrid thematic analysis can also be seen in a mixed methods approach to inquiry" (p.8). To conduct a thematic analysis of the qualitative data, Braun and Clarke's (2006) six-phase model was utilized, with both deductive and inductive forms of coding. This was done to triangulate with the quantitative data, as well as locate any new ideas which emerged. However, it is important to acknowledge that even deductive analysis has elements of induction, as the inclusion and analysis of data is subjective, based on the perspective and judgements of the researcher to decide what is valid (Sandelowski et al., 2009). While the Thematic Analysis model was presented in linear form by Nowell et al. (2017), they acknowledge that the researcher moves between the phases as necessary. The six phases are: "familiarizing yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming the themes and writing the final report" (Braun and Clarke, 2006 p.87).

Creating themes can be done deductively to locate specific information, or inductively where the themes emerge through the coding process (Braun and Clarke, 2006). This study utilized both deductive and inductive forms of coding in order to triangulate with the quantitative data, as well as locate any new ideas which emerged. To conduct a thematic analysis of the qualitative data, Braun and Clarke's (2006) six-phase model was utilized. While this model was presented in linear form by Nowell et al. (2017), they acknowledge that the researcher will move between the phases throughout the process. The six phases are: "familiarizing yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming the themes and writing the final report" (Braun and Clarke, 2006 p.87).

7.1. Qualitative Trustworthiness Criteria

To ensure that this thematic analysis research is seen as credible and legitimate, the Trustworthiness criteria from Lincoln and Guba (1989) will be used. The four criteria, transferability, dependability, confirmability and credibility are intended as parallels to the traditional quantitative markers of validity and reliability (pp.233-243). While these criteria date back to the 1980's, they are "original, widely accepted, and easily recognized criteria" and as such are "pragmatic choices for researchers concerned about the acceptability and usefulness of their research for a variety of stakeholders" (Nowell et al., 2017 p.3). According to Lincoln and Guba (1989), a study gains *credibility* when a reader can see a connection between what the participants have said and the researcher's interpretation of these viewpoints. Thick descriptions (Geertz, 2008) will be used to give the reader the context which serves as the basis for the researcher's interpretations. This can also assist with the *transferability* of the inquiry, enabling another researcher to apply the study in a new context. This study, while being carried out in a primary and middle-school context, is suitable for use in all teacher education programs in Norway. A study's dependability is dependent on its' transparency. Transparency requires that a researcher acknowledges their own standpoint and how their biases may colour the research and the interpretations which have been made. *Dependability* also requires that the research process be clearly and logically documented, with justifications given for each decision made throughout the research process. These justifications can also help to fulfill the final criteria of Trustworthiness, *confirmability.* Confirmability is only achieved when transferability, dependability and credibility have been established. These criteria require the researcher to "demonstrate how conclusions and interpretations have been reached" (Nowell et. al, 2017 p.3) and where they have been obtained from the data. Each of the six phases requires that the use of a reflexive journal, explaining the thought and decision processes undertaken by the researcher. This is done to create an *audit or decision trail* which can increase the trustworthiness of the study (Koch, 1994). As Sandelowski et al. (2009) rightly points out, inclusion and analysis of data is subjective, based on the perspective of the researcher to decide what is valid. However, ideally another researcher should be able to follow the audit trail and come to "the same or comparable, not contradictory conclusions" (Nowell et al. 2017 p.4). Due to the nature of this study. there was no opportunity for another researcher to analyse the data.

7.2. Familiarizing yourself with the data

Braun and Clarke (2006) recommend that before starting the coding process that the researcher documents their initial impressions which were obtained through the data collection and that they read all the raw data at least once. These impressions are presented in Table 6.

Table 6

Initial impressions from first reading of data.

Desire for practicality in university	Lack of practical relevance of pedagogy in 5GLU
Enthusiasm for praxis periods	Experiences of interdisciplinarity during praxis
Fear of teaching subjects outside their specializations	Teacher attitudes to interdisciplinarity and obstacles for implementation.
Conflicts between opportunities for employment and opportunities for subject specializations,	Informant perceptions of interdisciplinarity and deep learning.
Conflicts between praxis teachers and university teachers	Wishes for interdisciplinary learning in university.
Lack of communication between subject didactics and pedagogy	Experiences of interdisciplinary didactics in university

7.2. Generating Initial Codes

Creating a codebook prior to in-depth analysis can help to conduct a systemic review of the data which may "be useful for researchers conducting a realist, deductive, thematic analysis" (Nowell et al, 2017 p.6). Prior to the first reading, deductive *parent codes* were decided upon to aid triangulation with the quantitative survey data and were used to produce the interview guide. The deductive *a priori* formation of codes is consistent with Template Analysis, a sub-form of Thematic Analysis. These codes are decided upon before the analysis begins to "ensure focus on key areas" (Brooks et.al, 2015 p.218). These parent codes were University, Praxis, Curriculum, Confidence and Student Beliefs.

7.3. Searching for Themes

Braun and Clarke (2006) define a theme as something which "captures something important about the data in relation the research question and represents some level of patterned response

or meaning within the data set" (p.82). The initial number of codes may appear to be small, however generating codes to search for themes is a balancing act, starting with too many codes may reduce the researcher's ability to consider data from a neutral standpoint, while too few codes can leave a researcher feeling like they don't have enough direction to carry out their analysis (King, 2004 in Nowell, 2017). The raw data was initially analysed using the five parent codes above and preliminary themes were created. The theme *Coherence* was added to the Parent Code list after re-reading of the data. These are presented in Table 7. The terms *interdisciplinarity* and *interdisciplinary* have been shortened to "ID". King (2004) claims that researchers with little research experience may try to analyse every code in depth (in Nowell et. al, 2017), with this in mind, as well as the constraints and purposes of the study, it was decided to focus primarily on the parent codes and sub-themes, generating more codes or themes as necessary.

7.4. Reviewing the Themes

When reviewing the themes, the researcher reviews the extracts associated with each theme to "consider whether they appear to form a coherent pattern" (Nowell et al, 2017 p.9). The raw data is examined to make sure that all the relevant excerpts have been coded. Some of the themes may not have enough data to support them and are dropped. They may also be removed if there is too much overlap between them. New parent codes may be generated if there is relevant data which does not fit into a pre-existing code. (Nowell et al, 2017). Brooks et.al (2015) recommend an altering of the themes and re-coding of the data. After reviewing the parent codes and their sub-themes, the themes presented in Table 8 were found to be independent and have enough data to support them.

7.5. Defining the Themes

Nowell et al. (2017) state that the fifth phase of the thematic analysis, *defining the themes*, involves the researcher creating a narrative, presenting how each theme captures an aspect of the studied phenomena. Like the study from Gombrich and Hogan (2016), these themes will be presented in the Merged Results with associated quotes to justify their formation.

Table 7

Parent Codes and Preliminary Themes

University	Praxis	Curriculum	Confidence	Coherence	Student Beliefs
Experienced ID teaching between subjects.	Experienced ID	Knowledge of curriculum goals	Forced ID	Between subjects	Aims for ID in future practice.
Opportunities for Reflection	Attitudes of practicing teachers	Knowledge of themes	Praxis Shock	Between subjects & pedagogy	Deep learning vs. ID
Interdisciplinary Didactics taught	Practical Issues of implementation	Conceptual understanding of ID and deep learning.	Plans for future study	Between university and praxis	Desires for Teacher Education.
Theory Presented		Fear of Mathematics			

Table 8

Qualitative Themes

Research Question	***Theme 1***	***Theme 2***
RQ1: Perceptions of ID	Understandings	Beliefs
RQ2a) Experiences at university	ID Didactics	Coherence & Loss of Didactics
RQ2b) Experiences in Praxis	ID Experiences	Obstacles to ID
RQ2c) Comparison	Subject Specialization	Forced Interdisciplinarity

8.0. Convergent Method - Merging and Abductive Process

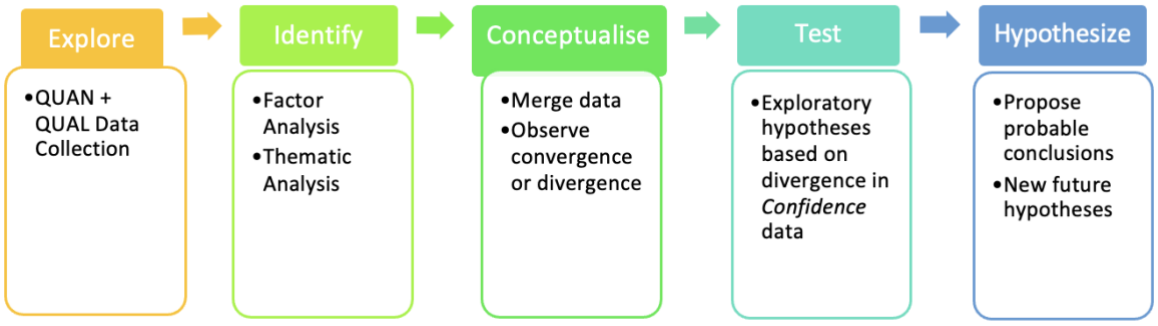
According to Creswell (2018) a convergent design involves a merging of data sets to demonstrate relationships between the qualitative and quantitative data. Merging is an essential

part of a convergent design, demonstrating a complexity of data which cannot be obtained from one method alone, with both quantitative and qualitative data sets are to be considered equal. A strength of this method is that data convergence may improve the level of credibility and validity achieved within a mixed method study (Jick, 2011). Creswell and Plano Clark (2018) identify that explaining divergence is a challenge in convergent studies, with Frederiksen (2020) believing that this divergence negatively impacts the validity of the data to the point it cannot be used. Meanwhile from an abductive perspective, Jick (2011) disagrees, believing that "divergence can often turn out to be an opportunity for enriching the explanation" (p.607).

Proudfoot (2022) also considers divergence as positive, enabling the generation of new ideas, claiming that "the notions of abduction and retroduction can then begin to be brought to bear, in the form of identifying the unexpected or surprising gaps in explanation or theory (abduction) and reformulating theory to account for this (retroduction)" (p.8). Abduction is used "where data collection is used to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth" (Mitchell, 2018 p.105). Mitchell's quote has been turned into a process model which has been used in this study to ensure the abductive process has been followed (see Figure 3). Thus far the process has entailed mixed-method data collection using deductive and inductive forms of survey generation and thematic coding. The data sets have been analysed and placed into a conceptual framework, based on survey constructs and qualitative themes. The data was then merged and examined for convergence and divergence. The qualitative theme *Forced Interdisciplinarity* indicated divergent results with the quantitative data. This resulted in new hypotheses regarding the *Confidence* variables to be formulated and tested for significant differences, again using the Wilcoxon signed rank test. It was hypothesized that the informants feel significantly more confident teaching within their subject specializations than in all subjects. The results will be presented in the results for Research Question 2c). There are several ways which data can be merged in a Convergent Mixed-Method Design: "side-by-side comparisons, merged data analysis and data transformation" (Creswell and Plano Clark, 2011 p.251). The merged results will be presented below and analysed together with theory in the discussion to make it easier to see convergence or divergence between the datasets. To differentiate between QUAL and QUAN participants, the interviewees will be termed informants and those who answered the survey will be referred to as respondents. First the quantitative results will be presented and then the qualitative findings.

Figure 3

Abductive Process



8.1. Threats to Convergent Validity

Creswell and Plano Clark (2011) present potential threats to validity when merging data under three sets of issues: "data collection, data analysis and interpretation" (pp.240-241). These threats to validity have been considered and addressed. In terms of data collection, the samples were drawn from the same population, and the difference in sample sizes has been considered. The quantitative results were not analysed before the interviews took place, to avoid introducing potential bias. To ensure that both sets of data were related to the same topics, triangulation was used to create the interview guide based on the survey constructs. To counteract data analysis issues, matching quantitative scales with qualitative quotes and themes were used to justify convergence or present divergence between the data sets. In terms of issues relating to interpretation, any divergent findings are presented together with hypothetical explanations proposed for why this may have occurred. This is presented in the discussion. By presenting the results together, it is hoped that there will be equal emphasis on both qualitative and quantitative methods.

9.0 Merged Results

9.1. How do prospective teachers perceive interdisciplinarity as a pedagogical approach?

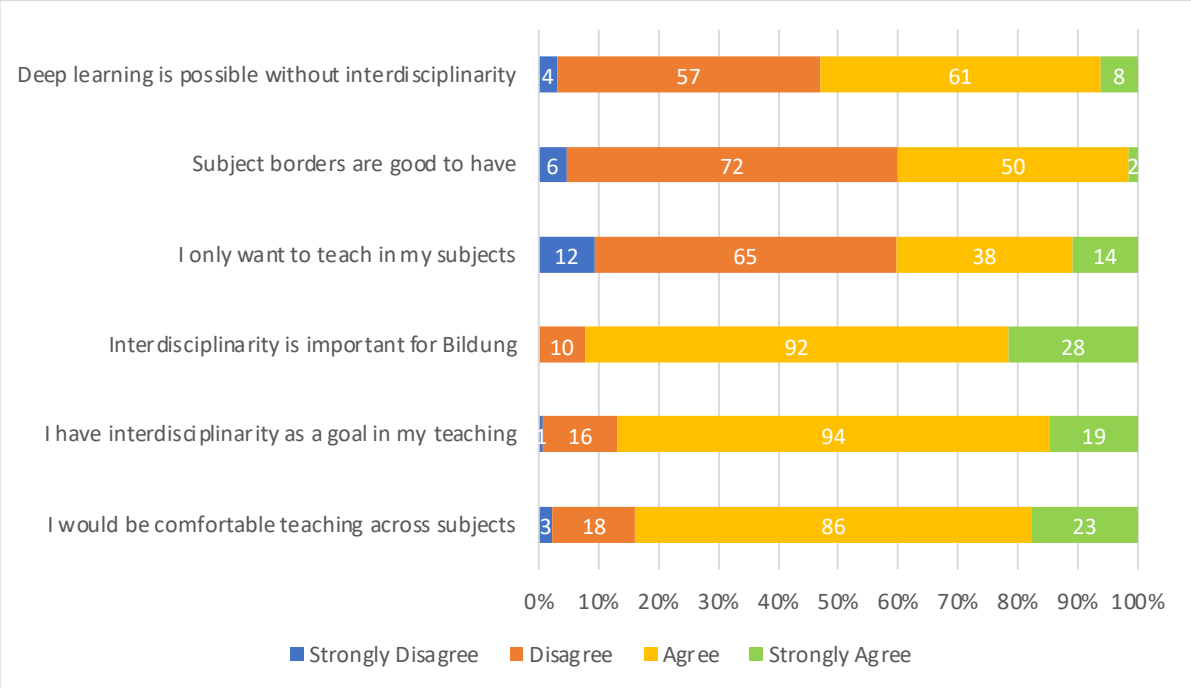
9.1.1.Quantitative Results

The survey respondents had positive attitudes when it came to interdisciplinarity, with approximately 90% of respondents agreeing with the variables “I have interdisciplinarity as a

goal in my teaching" (N=113, Mdn =3.0) and "interdisciplinarity is an important part of the process of Bildung" (N=120, Mdn=3.0). However, when asked if they only want to teach within their subjects of specialization, almost 40% of the respondents agreed to this statement (N=52, Mdn=3.0), with 11% strongly agreeing (N=14). The same number of respondents also agreed that subject borders are important to have. In terms of the variable, "Deep learning is possible without interdisciplinarity", there was a quite even division between the respondents, with 53% agreeing that deep learning is possible without interdisciplinarity (N=69), and 47% believing that interdisciplinarity is essential to deep learning (N=61). This variable scored a lower median than the other five variables (Mdn = 2.0) The frequency graph is presented in Figure 4, descriptive statistics are in appendix D1.

Figure 4

Frequency Tables Belief Variables



9.1.2.Qualitative Themes

Understandings

The informants all presented similar conceptual understandings of interdisciplinarity. They referred to it as where subjects are "mixed" or "melt together". The informants saw this as thematically based teaching and learning, where teachers corroborate their teaching around a central theme or topic. All of the informants presented a multi-disciplinary view where the

subjects were still clearly defined, and the teacher has the responsibility for collaborating with the other subject teachers in order to provide an interdisciplinary learning opportunity, as opposed to team teaching. Only two of the informants Loke and Sunniva presented an understanding of interdisciplinarity involving a generalist teacher who could "throw things out here and there" (Sunniva). The informants presented interdisciplinarity as a means to develop content knowledge by linking it to a relevant theme. They generally did not refer to the transference of skills or knowledge from one discipline to another, or the possibility for pupils to develop an understanding of interdisciplinarity or develop 21st century skills. Loke was the only informant who spoke about using interdisciplinarity to solve problems and the development of interdisciplinary understanding and skills, saying:

> *you gain a deeper understanding which sits inside you so then you can learn other things. Then you can connect the dots between them yourself. It increases students' competency because they have to connect those dots. But then, there is also interdisciplinarity and it is about seeing how the different subjects connect to each other.*

When the informants were asked about the implementation of interdisciplinarity, there was some confusion relating to when a learning opportunity would be considered interdisciplinary. The informants appeared to be looking for a way to categorize an interdisciplinary lesson beyond the simplistic definitions they had provided earlier in the interviews. When considered from a practical perspective, it appeared to be no longer sufficient to just say that the "subjects are linked together". This was particularly evident from Finn who said, "when you say interdisciplinary, I don't really know what it is, but I don't, or, no, I know what it means, but I don't know what it is". He appeared visibly frustrated by the lack of a clear-cut definition or pedagogy associated with interdisciplinarity. He perceived his own knowledge as lacking when it came to interdisciplinarity and his frustration was evident during several points of the interview.

From the informants' point of view, interdisciplinarity was explicitly planned between two or more subjects, however these subjects were to have an equal focus, or weight. This clear-cut approach seemed to help the informants remain accountable in terms of subject hours and competency goals, however it complicated how they saw interdisciplinarity. The informants acknowledged that while they used several subjects in a lesson, for example, a mathematical

timeline in a Norwegian history lesson, this was rarely made explicit to the pupils, thus the interdisciplinary aspect was lost. Throughout the interviews the researcher and the informants co-determined that it is explicit acknowledgement of cross-disciplinary content and subsequent reinforcement by the other subject teachers is what enables pupils to create valuable interdisciplinary connections and interdisciplinary understanding. The informants perceived that that in the humanities, particularly in Norwegian, that interdisciplinarity could occur organically throughout the curriculum, otherwise known as *automatic interdisciplinarity* (Doig & Jobling, 2016), while mathematics and science would require more conscious collaboration. Likewise, many of the informants were quick to point out that social science or Norwegian should have responsibility for implementing the interdisciplinary themes. However, during her explanation Sunniva realised that this would mean that these subjects would simply get more competency goals, without interdisciplinarity being achieved. This led the informants to be asked who has the responsibility for implementing interdisciplinary teaching in the classroom.

When the concept of equal subject weight was removed from the equation, the informants became more uncertain about the implementation of interdisciplinarity with Finn exclaiming, "what is my responsibility, how and to what extent is something interdisciplinary and when is it not!?" Finn was constantly reflecting out loud throughout the interview. He recounted an example from his praxis, where a science teacher was complaining about "losing his lessons" due to an interdisciplinary activity. At first, Finn empathised with the science teacher, yet appeared to openly reflect during the interview saying:

> *Finn: But then I didn't think about the fact that you are working in a way with the same theme, but with different glasses.*
>
> **Interviewer: You don't lose those lessons?**
> *Finn: Nooo (hesitant)*
>
> **Interviewer: Is there something about a subject's integrity?**
>
> *Finn: Yes, but it depends on which glasses you have on when you are working or when you get the students to work with a theme I want them to speak English to develop their vocabulary...But I guess I am really trying to get the students to reflect*

on the environment, and we do it in English....But now I have to think to myself, where do I, the English teacher come in the lesson?

The informants all were preoccupied with achieving the set competencies for their subjects, with the idea of accountability leading to the informants being more sceptical about interdisciplinary approaches. They acknowledged that interdisciplinarity was an approach which would require extra time and resources, with Loke claiming it was for "teachers who go up and beyond...and put in the extra work to make it happen". Yet, Sara saw interdisciplinarity as inevitable saying, "how the school is evolving right now, I believe that in a way these subject borders will be more washed out". She felt that even as a second-year student, it was necessary to learn about interdisciplinarity.

A majority of the informants expressed a desire to work in a multi-disciplinary way, remaining within their subjects. When the informants were asked if they required content knowledge of another discipline in order to work in an interdisciplinary manner, there was a variety of answers. Loke and Sunniva expressed that they were eager to know what the other subject teachers were doing in their lessons so they could reinforce them in their own lessons with the class. Meanwhile, Finn claimed that he would just trust the math teacher to know what he was doing, while Aslak was more uncertain. Despite his reluctance to teach mathematics himself, Aslak considered it essential for him to have content knowledge of the discipline in order to collaborate with his colleagues more effectively, yet this made him very nervous. As a fifth-year student, he was worried that he will have nothing new to contribute to his future workplace in terms of interdisciplinary planning:

When it comes to the longer planning sessions and using the different competency goals in a little bit of a balanced way, this is something I have thought about a lot when I start right? I know we are supposed to plan together and so on, but I don't have so much to contribute as a new teacher I don't think, not in that area.... I feel like an imposter, or a type of fraud, like I said an imposter. You are supposed to come with so much, but you feel just small, you do…. you sit like a question mark.

Meanwhile Loke, as a second-year student, considered interdisciplinarity as an ambitious teaching practice, and something that he "was just not ready for". As a novice teacher, he felt that needed to focus just on the subjects which he specialized in.

Beliefs

Despite the perceived difficulties and inadequacies felt by some of the informants, they could all identify considerable benefits of an interdisciplinary approach. The informants believed that interdisciplinarity provides a potential opportunity for pupils to make connections and gain more perspectives on which to build understandings of a theme. These connections were described as "hooks to hang knowledge" (Sunniva) or the ability "to connect the dots for yourself" (Loke). All of the positive perceptions about interdisciplinarity from the informants were based on the idea of building a more holistic understanding of an issue or theme. Sara and Sunniva both saw interdisciplinarity as a way of connecting learning to real-life experiences, which they saw being both motivating and confidence-building for pupils. Sara justified her point of view by saying, "life is interdisciplinary".

Both Sara and Sunniva described situations where interdisciplinary approaches may trick a pupil into doing a subject they may not feel or be good in, without them even knowing it. Sunniva, who is specializing in physical education, recalled an example from her own schooling where a math lesson was integrated into physical education. Sunniva found this experience sat with her "because not everyone learns from blackboard teaching". This one experience influenced her entire approach to her future professional practice. She was incredibly positive about interdisciplinary teaching.

Again, Finn was more sceptical regarding the value of interdisciplinarity. He believed that many teachers only implement interdisciplinarity to "check off a box", and that there needed to be better quality control of interdisciplinary approaches. He only saw the benefit of interdisciplinarity being if "the pupils can build a bigger understanding and skills through the interdisciplinary project than they would from something NOT interdisciplinary".

When speaking about the benefits of interdisciplinarity, as mentioned, many of the informants brought up the opportunities to make more connections relating to a theme, this led to asking the informants if they believed interdisciplinarity contributed to deep learning. The

responses ranged the whole spectrum, from deep learning not needing interdisciplinarity (Finn, Sara) right up to deep learning absolutely needing interdisciplinarity (Diana and Aslak), with Diana claiming that education would be "too narrow and deficient" without it. She described interdisciplinarity using the metaphor of a plank of wood as a topic or a theme, and each nail in the plank was a new perspective. She focused on the individual construction of knowledge by the pupils, and how interdisciplinary practices and a focus on deep learning enables pupils to become autonomous and build understandings based on their own, individual experiences:

Diana: *Deep learning to me, is a basis for creating autonomy and then there is interdisciplinarity and I think again about the connections, it isn't just spikes but the whole plank, so one understands how things hang together, how things overlap and what meaning they have.*

Again, the responses of the informants was changing and context dependent. Without the "hard" sciences, the informants were more open to deep learning occurring through interdisciplinarity, believing that languages and humanities lent themselves to one another. In science and mathematics however, most of the informants believed deep learning did not require interdisciplinarity. Loke perceived interdisciplinarity and deep learning occurring in a cycle which he saw as beneficial:

> *I believe deep learning leads to interdisciplinarity…learning things in a deep way enables the students to draw the interdisciplinary connections themselves, eh...but at the same time with focus on interdisciplinarity you also get deep learning. It is a good cycle*.

While theoretically positive to interdisciplinarity, there were varying degrees of support from the informants for an interdisciplinary approach in classrooms. This was complicated for two reasons. Firstly, it was apparent that the informants had not deeply reflected upon the full implications of interdisciplinarity in a school or classroom context, with comments such as, "this has been so valuable" or "I have never thought about this before" occurring in almost all seven interviews. These interviews appear to have been arenas where the informants reflected and constructed their own beliefs and values regarding interdisciplinary teaching which changed as the interviews progressed. As such, their attitudes towards interdisciplinarity waxed and waned. Idealistically, the informants were all positive towards interdisciplinarity, when

practical aspects such as collaboration or accountability came up in the interview this brought more hesitance for interdisciplinary approaches. The informants' were less positive towards interdisciplinarity when it involved them teaching outside of their subject specializations.

9.2 To what extent and in what ways is interdisciplinarity experienced in university?

There were two different ways which (inter)disciplinarity presented itself in the university context: interdisciplinary didactics and program coherence. *Interdisciplinary didactics* refers to the explicit teaching of ways in which prospective teachers can introduce interdisciplinarity into their professional practice, as well as familiarity with the curriculum and related theory. *Program Coherence* refers to the communication and collaboration between subject-specializations with each other and with pedagogy. This section focuses on how program coherence influences the informants experiences with interdisciplinarity.

9.2.1. Quantitative Results

University

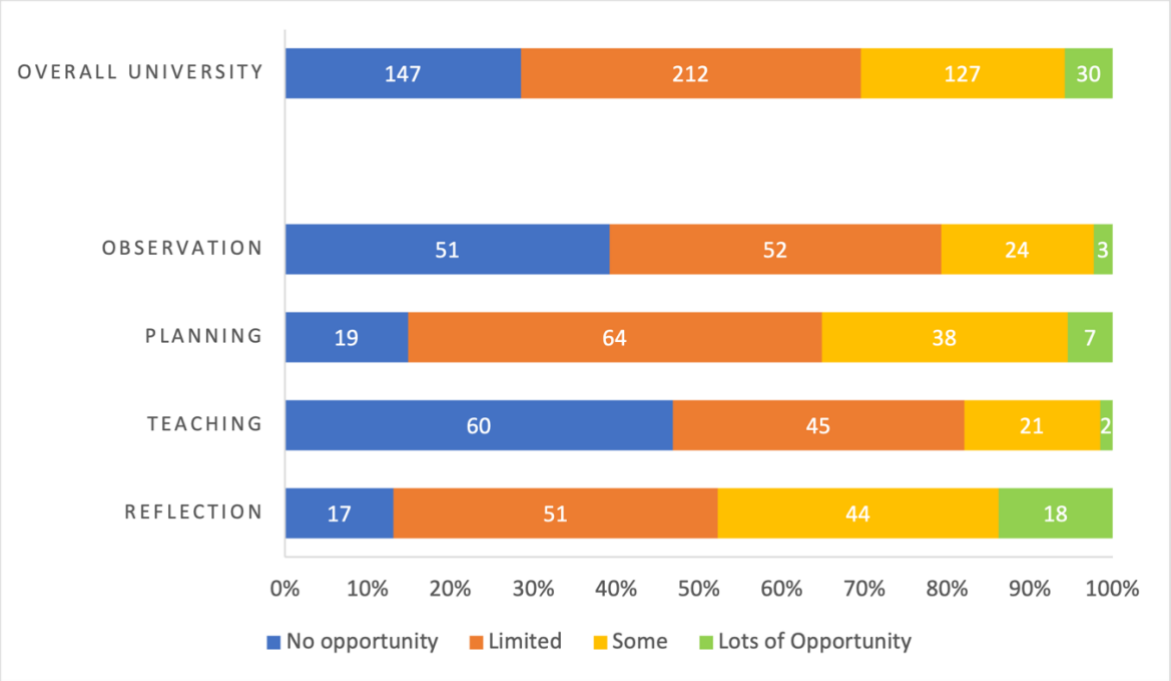
The respondents indicate that they have the least amount of opportunity to teach interdisciplinary teaching and learning in university, with 81% of respondents indicating no or little opportunity to do so (N=105, Mdn=2.0). The respondents claim they have little to no opportunities to observe in an interdisciplinary manner (81%, N=103, Mdn=2.0) or plan (63%, N=83). However, the respondents indicate they have the most opportunity to discuss and/or reflect upon interdisciplinary teaching and learning, with 48% of respondents claiming they have some or a lot of opportunities for reflection (N=62, Mdn=2.0). The average percentage of respondents who claim to have a lot of opportunities to experience interdisciplinarity is 5.75%, however if the element of *reflection* is removed, this drops down to 3.1%. The frequency graph from the University scale are presented in Figure 5, descriptive statistics are in Appendix D2.

Curriculum

The respondents report having a high level of opportunities to become familiar with the curriculum (Mdn=3.25). The descriptive statistics are presented in Figure 6 and frequency tables are in Appendix D3. Over half of the respondents indicated that they have had a lot of

Figure 5

Frequency Graph University



opportunity to become familiar with LK20 (N=67), while 42% (N=55) indicate that this opportunity was extended to the new elements of the curriculum, interdisciplinarity and deep learning. However, the percentage dropped when it came to the interdisciplinary themes, with 36% indicating a lot of opportunity (N=47). In terms of familiarity with the competency goals across the curriculum, approximately 25% of respondents indicated they have a lot of opportunities to become familiar with the curriculum in both programs, 1 - 7 (N=33) and 5 - 10 (N=35). This is despite an underrepresentation of respondents in the 1 - 7 program.

Coherence

As aforementioned, these three coherence variables were included as they correspond with data emerging in the qualitative interviews. While the respondents were asked about coherence, it was not anticipated this would emerge as such an influential theme relating to interdisciplinarity. The lowest median appeared the variable, "the teachers who teach in teacher education explicitly referred to content and terms which appear in other subjects than their own" (Mdn=2.0), with 63% of respondents disagreeing (N=70) or strongly disagreeing (N=11) with this statement. The other three variables were equal in median (Mdn=3.0), with a more even distribution in their scores. The most positive responses were to the variable, "I am met

with the same ideas regarding teaching and learning across subjects", with 72% of respondents agreeing (N=82) or strongly agreeing (N=11) with this statement. The frequency graph is in Figure 7, descriptive statistics are in Appendix D4.

Figure 6

Frequency Graph Curriculum

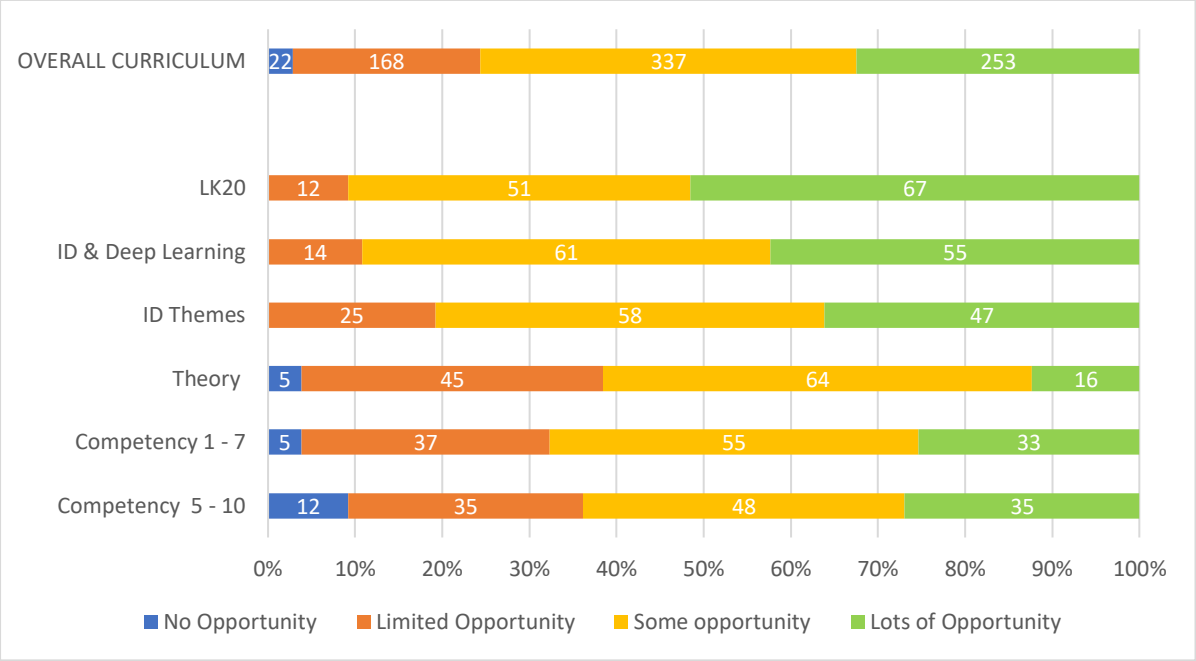
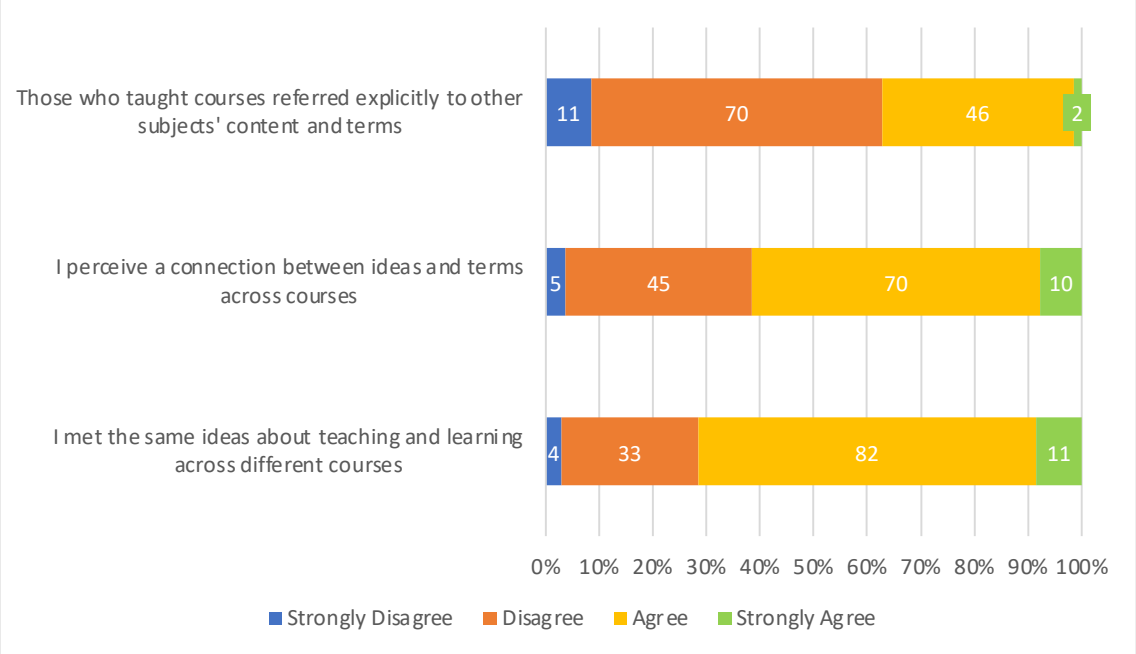


Figure 7

Coherence Variables Frequency Graph



Open-Ended Variable

In the survey the respondents had the opportunity to comment on any aspect of teacher education they liked. Only 5GLU respondents chose to use this opportunity, predominantly commenting on the lack of relevance of pedagogy, missing didactics and the wish for more instruction regarding how to teach in an interdisciplinary manner. The full set of comments are presented in Appendix D5; however, five examples will be presented here, two relating to interdisciplinarity, two relating to the relevance of pedagogy and one relating to the connection between subject didactics and future professional practice (Table 9):

Table 9

Quotes from open-ended variable

“We hear a lot about how interdisciplinarity is important, however, there are few examples presented in how to actually work with it”.
“I wish we could get more teaching about how to work in an interdisciplinary way within our subject specializations”.
"I think everything we learn in pedagogy is pretty irrelevant to my working life".
"The pedagogical subjects are very important, but the way they are conducted at university has been very disappointing. The teachers put the responsibility on us and take responsibility only for a small portion of what is necessary to learn, which is often very distant from our future professional practice. Overall, this is a subject with a lot of potential, but the prioritization of literature (pensum) has been disappointing."
"I experience that the teachers focus on the subject specializations as opposed to everything else we have to deal with as teachers. I miss more information on how to deal with parent and pupil conversations and meetings. In the subjects I experience that we learn a lot of theory, but not much on how we actually teach."

9.2.2. Qualitative Themes

Interdisciplinary Didactics in University

The informants were asked about their experiences with interdisciplinarity in pedagogy. The informants had limited experiences with interdisciplinarity, but all agreed they had been familiarized with the new curriculum and the interdisciplinary themes. However, they indicated that this was done superficially, with Finn calling it a "type of awareness". When he was asked about the presentation of interdisciplinarity he said that it was brought up, “very simply, like in a sub-ordinate clause, [where the teacher says] “yes, it can be doing something like that, finishing a project like that", and then we move on to the next slide.” This did not appear to transfer into an understanding of interdisciplinarity, illustrated by the fact none of the informants could name all three of the interdisciplinary themes. The informants attributed this superficial coverage to the large number of topics needing to be covered by pedagogy. They felt they did not receive the time they felt they needed to work in-depth with a concept, with Aslak claiming pedagogy is "pang, pang, pang!" Meanwhile, Finn and Aslak mentioned that pedagogy in the fifth year had become too abstract to be relevant. This was also commented on by the female respondents, who said while they did not feel that way about pedagogy, there were a lot of their fellow students who did.

The majority of informants could not recall specific times when they could observe, plan, teach or reflect on an interdisciplinary teaching session. This is despite 2GLU being observed recently having a thematic planning lesson, where they had to link as many disciplines as possible to a common theme. This may further reinforce what the informants indicated about not having enough time to focus on a specific topic or teaching strategy. One exception is Sunniva, who recalled working in an interdisciplinary way in pedagogy, sitting with students taking other specialties to work on a problem together. However, most of the informants experienced these assignments as starting with the sentence, "consider your subject specialization", something which they did not consider conducive to interdisciplinarity.

There was a similar experience in subject-didactics, however two of the informants could recall single interdisciplinary experiences in science and physical education. Loke described a learning experience where an entrepreneur was invited in for a week. They were required to solve a complex, real-life problem which involved working across different disciplines and

considering multiple perspectives. Loke saw the value for his pupils saying, "you can take it with you in praxis and now I think that this project was gold worth for the pupils, that they get genuine problems they need to solve". Sunniva related a recent experience in Physical Education where science and physical education were combined to create an orienteering course, filled with biology-centred questions. The only two experiences with interdisciplinarity involved science.

In neither pedagogy or subject-didactics could any of the informants could recall being presented with any theory or empirical data demonstrating the benefits of interdisciplinary teaching and learning. They had not thought about it before, but all of the informants considered it useful. Sara explained that she had recently read an article about the positive impact of play in the classroom and how it had been successful. She definitely thought that connecting theory to practice would be useful in the case of interdisciplinary teaching and learning. Finn agreed, demanding to know, "why [should we do this]? What's in it for the pupils?".

Coherence and the Loss of Didactics

Prospective teachers study both pedagogy and subject-didactics courses. The informants referred to pedagogy as an umbrella, providing overarching ideas regarding child development, learning theories or Bildung. The informants spoke highly of the pedagogical subjects in the early years, claiming they were practical and relevant. However, this disappears later on, which the fifth-year informants attribute in part, to a lack of pedagogy in years 3 and 4. They also felt that the content in 5th year pedagogy was focused on abstract concepts such as Bildung, which they felt were irrelevant for their future practice. Meanwhile subject didactics is responsible for presenting subject content and didactics related to their discipline. The courses are so segregated that when the informants were asked about interdisciplinarity in their study programs, they frequently mentioned pedagogy and subject-didactics as an example of interdisciplinarity. This implies a lack of program coherence, with Aslak saying,

> *They feel like two different programs, yes, they do, we feel they are very divided and the only thing that connects them in my head is that they are one and the same education, but they don't know each other, they don't know what is going on in the different subjects and there is of course a reason for it, and I understand but you don't get any sort of connection.*

The informants, apart from Aslak, felt that the pedagogical subjects did not frequently refer to subjects specifically. Aslak acknowledged that this did occur sometimes but could not come with a concrete example of when this had occurred. The majority of the informants claim that the subject-didactics courses rarely referred explicitly to pedagogy, and even more rarely to another subject. A consequence of this lack of coherence or communication between the subjects and pedagogy appears to result in students missing elements of their education, predominantly when it comes to didactics, with Finn saying:

> *We often ask in pedagogy, "why haven't we learned this here?" And then the pedagogy [teachers] say, "you aren't supposed to learn it here, you are supposed to learn it in the subject didactics", but we haven't learned it in the subjects!*

The informants claim that subject-didactics are responsible for teaching didactics specific to their discipline, but they often perceived the faculty as more preoccupied with subject content. Louise, Diana, Loke, Aslak and Finn all claimed that the level of specialization in their subjects was at such a high level that they felt it irrelevant for their future professional practice. Aslak and Finn both complained about the level of Norwegian texts they had, feeling they were too advanced to ever be used with pupils, even saying they had a book in Swedish they could never use. Loke had a similar experience in science, so he asked his teacher if the content was relevant to his future pupils. His teacher replied, "not really". Even more startling is that Diana claimed that a quarter of her class had quit teacher education entirely, which she attributed to the intense focus on subject content.

In some cases, the heavy focus on content influenced the program structure of some specializations. In fifth-year religion the students shared their class with fourth-year philosophy students. This resulted in there being "no mention of school or didactics at all" according to Diana. Louise was extremely frustrated by this cross-departmental situation, saying:

> *No, no, I can only say that it was fucking bad, because we are together with Ethics and Philosophy, who aren't becoming teachers. It doesn't work at all. We are on completely different planets…. they are super theoretical, and we are extremely practical. Awfully bad clash.*

While the cross-program collaboration between religion and philosophy was not successful, the informants were very positive towards collaborating with special education, feeling that it was much more relevant to their future professions. The informants who took thirty credit points in Special Education (Finn, Aslak) felt that their program was extremely relevant and one all prospective teachers should take. Without a focus on didactics or explicit linkages between the subjects, opportunities to develop interdisciplinary understanding and didactics appear severely limited. The informants expressed an interest in building their competency in didactics, with Finn claiming that:

> *It is mentioned approximately every year as I have understood it, we students have been yelling for methods, yes, and then you get the answer of...."yes, but you are meant to develop your own methods".*

He continued by saying, "we have this huge backpack of knowledge, but not how we can apply/transfer it." The segregation between the subjects appears to have fixed the mind-set of the informants, for example, that there is only one set of didactics for the humanities which cannot be transferred to the sciences or languages. Several of the informants felt that they would need to develop a new way of thinking (Louise, Sunniva and Sara) or "didactic map" (Sara) if they were to teach a subject with which they were unfamiliar, instead of being able to find transferable strategies or content. All of the informants were eager to learn explicit didactics for their subjects but also to learn about interdisciplinary didactics. They see this currently only being possible in pedagogy, as the structure of teacher education mean that this is the only place that they meet students taking other specializations. They felt that their subject didactics classes were too specialized and did not refer to ways which they connect their subject to others.

9.3 To what extent and in which ways is interdisciplinarity experienced in praxis?

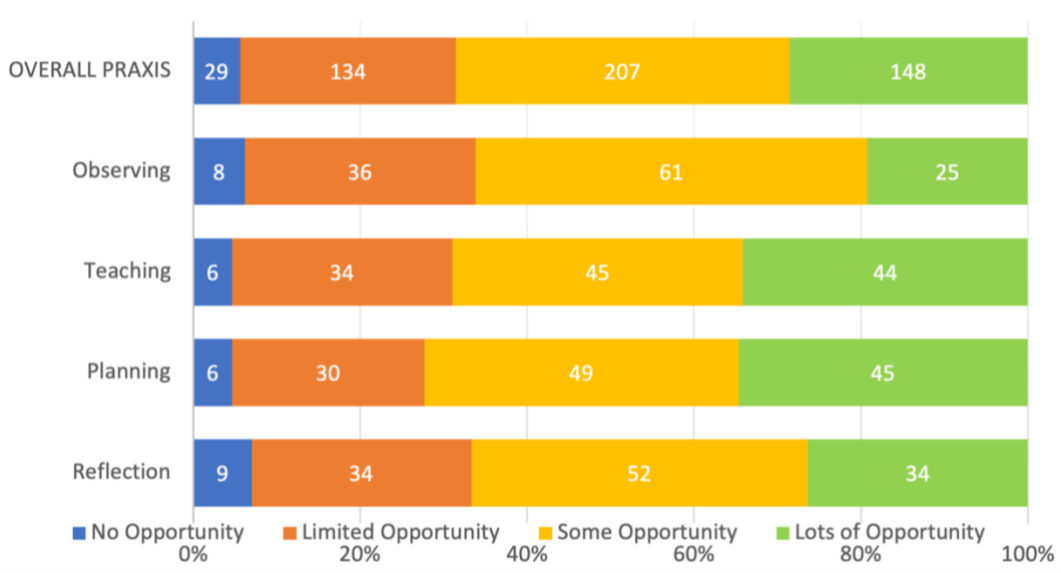
To answer this research question, the Praxis scale will be used from the quantitative survey and two themes from the interviews. The first theme related to concrete experiences with interdisciplinarity. The second theme: *Obstacles to Interdisciplinarity,* appeared inductively when the informants started to mention the praxis teachers' attitudes towards interdisciplinary teaching and learning. Based on this recurrent theme, the informants were asked to reflect on their experiences with interdisciplinarity in praxis and talk about any factors they perceived as relevant in regard to the implementation of interdisciplinarity in schools.

9.3.1 Quantitative Results

The quantitative results indicate high levels of opportunity (Mdn = 3.0, IQR=1.31) for prospective teachers to experience interdisciplinarity in praxis. They report the most opportunities to plan in an interdisciplinary way whilst out in praxis, with 72% stating they have some or a lot of opportunities to do so (N=94). Despite almost 70% of respondents indicating they had the opportunity to teach in an interdisciplinary way in praxis (N=89), the report a slightly lower amount of opportunities to reflect upon this teaching, or the teaching of others (66%, N=86). A Frequency graph is presented in Figure 8 and the descriptive statistics are in Appendix D6.

Figure 8

Experiences with Interdisciplinarity in Praxis



9.3.2 Qualitative Themes

Experiences with Interdisciplinarity

The informants had varying experiences with interdisciplinary teaching and learning in their praxis schools. All of the 5GLU informants and one from 2GLU had experienced interdisciplinarity to some degree while out on praxis. Loke and Sara from 2GLU claimed they had not experienced any interdisciplinarity in terms of planning or teaching, with Loke explaining that "we have only had two praxis periods and then you are just trying to hold your

head above water". While this is expected for new teachers out in praxis, these two informants claim that they did not observe their praxis teachers using interdisciplinarity in their teaching either. Yet it appeared that interdisciplinary practices could be hard to recognise at the beginning of teaching education, with Louise from 5GLU recounting, "we had a health week one time, and I did not really understand what kind of subject it was. It was the first year out, so we did not really understand entirely what had happened." However, later in her study progression, Louise experienced what she called an "interdisciplinary week," where the teachers worked together on a theme. She stated that she would implement interdisciplinarity if she could, claiming that "you would have gone through it [a topic] thoroughly, if you are then, finished in a way".

This, "finished in a way" appears to be a common theme in schools, with the interdisciplinary themes being addressed in a week or a day, as experienced by Sunniva, Finn and Diana. Aslak was the exception to this form of tokenistic interdisciplinarity, he consistently experienced project work over several weeks with a common theme presented to the pupils. Having worked as a casual teacher since the beginning of his studies he has had more opportunities to observe, plan and recognize interdisciplinary teaching than the other informants. Yet through his descriptions it appeared that his school was better than the other praxis schools at consistently implementing interdisciplinary teaching practices, though these still appeared to be multidisciplinary.

The informants reported opportunities to observe interdisciplinary teaching, yet it appeared that when it came to planning and teaching, the informants were also predominantly observers, with the exception of Aslak who worked in school outside of his praxis. The informants reported even fewer experiences of reflecting upon the interdisciplinary teaching, either of them together with their praxis teachers, or the praxis teachers themselves collectively reflecting on the experience. The informants' experiences were all multidisciplinary, as opposed to interdisciplinary. A slightly different example was recounted by Sunniva, which will be presented in the next theme: obstacles to interdisciplinarity.

Obstacles to Interdisciplinarity

Sunniva's recounted experience with interdisciplinarity involved a single day focused on mathematics, where teachers were required to put as much mathematics into their lessons as

possible. For the Norwegian lesson, mathematics appeared in a very superficial way, counting as many double consonants as they could in a minute and putting them into groups. It was difficult to see how relevant mathematics or Norwegian learning occurred within the lesson. Despite this, or perhaps because of it, the Norwegian teachers expressed considerable anxiety having to incorporate mathematics into their lesson. This is reflected in this interview excerpt from Sunniva:

Sunniva: *There were some who simply did not feel safe in another subject, I really experienced it when they said we were going to have a math day, and there were some teachers who were really like, afraid of math saying, "we cannot do it like this..." but no, you must not go about doing algebra, we had to help each other and find something different*.

Interviewer: Which grade was this?

Sunniva: *The teachers, I do not know, under fifth grade at least.*

Interviewer: But they can do fifth grade math?

Sunniva: *Yes, I thought that as well, so I was a bit like, "now, you don't have to make it so complicated, but people can be a bit negative to it, yes."*

Teacher insecurities or rather, reluctance, seem to colour the experiences that the informants had with interdisciplinarity out in praxis. When the informants were asked the question, "from what you have observed in praxis, to what extent do you think that the implementation of interdisciplinary teaching will work?" they had the following responses regarding teachers' attitudes:

Sara: *I think probably there are a lot of teachers who will be a bit negative, now that its yet another thing, or now we have to do things in a completely different way, and that demands a lot more collaboration with new people who again think differently, and everyone has their own competency goals they want to achieve.*

Louise: *Yes, I think it can be a strength. The only negative, or challenges come from when you have those "stubborn goats" who work in schools for fifty years and do not want to collaborate or work on it. Because there are many of those, and then it becomes difficult…*

Diana brought up the same issue as Louise, with older or more stubborn teachers being reluctant to engage with new strategies when "the old ones work" (Diana). Teacher attitudes seem to be critical when it comes to implementing an interdisciplinary approach, with all of the informants agreeing that if interdisciplinary teaching and learning was to be implemented in a school, it was dependent on the enthusiasm, motivation, and collaboration of colleagues, with Diana stating that "you are completely dependent on the entire collegium being interested: that "we are in"!

Aslak considered the traditional use of textbooks detrimental to the implementation of interdisciplinarity, claiming that "schools have old textbooks and teachers want to use books". To him, it seemed that schools and teachers were unwilling to let go of the traditional methods of teaching and learning, despite the new focus on interdisciplinarity in LK20. The lack of clarity surrounding the concept of interdisciplinarity appeared to cause confusion and frustration for both praxis teachers and the informants. Finn appeared visibly frustrated, and saw a lack of knowledge and understanding as an obstacle for implementing interdisciplinary practices saying:

Finn: *Because I do not know if there is enough knowledge and understanding about why it is, why it needs to be done in a way, or perhaps it is enough knowledge about why it should be done, but not understanding about how it should be done....and in what way it provides better learning for the pupils, as opposed to doing it another way.*

The informants observed that the teachers in praxis appeared afraid to lose the time they have allocated to their own subjects, with interdisciplinarity again being seen as threatening. According to some of the informants, for example, Sunniva, the praxis teachers were perceived as feeling that interdisciplinarity was a superfluous form of teaching, wanting to get it over with. On the contrary, Louise mentioned that interdisciplinarity could be a way to save time in a cluttered curriculum, yet logistics and time for collaborative planning were brought up by Loke and Finn as potential obstacles for the implementation of interdisciplinarity in schools.

Loke used the example of the Norwegian teachers planning together for the whole school year and considered interdisciplinarity something which would occur "on top of" the regular planning.

9.4. How do experiences with interdisciplinarity compare between university and praxis?

This research question aims to compare the amount and nature of experiences prospective teachers have in university and in praxis. Two themes came up in the interviews: *Subject Specialization* in university and *Forced Interdisciplinarity* in praxis. While these two themes could have appeared under the two previous research questions, it seemed appropriate to put them here, as the requirements for university and praxis appear to stand in stark contrast to one another, strongly influencing how interdisciplinarity is experienced in each learning arena. These themes, although appearing inductively, correspond to quantitative *Confidence* scales.

9.4.1 Quantitative Results

University vs. Praxis

Based on the literature, it was a hypothesized that prospective teachers would experience more interdisciplinarity in praxis than in university. The difference in the medians is 0.8, with a median of 3.0 for praxis and 2.2 for university (Table 11). The paired Wilcoxon Signed Rank test demonstrates that the respondents perceive significantly more experience with interdisciplinarity in praxis than in university (T= $p<.001$) rejecting the null hypothesis. Overall, 70% of respondents claim to have some of a lot of experience with interdisciplinarity in praxis (N=89), compared to only 31% in university (N=40). Looking at the individual items which appear in both scales: observing, planning, teaching, and reflecting, the respondents reported more experiences in praxis for all four items. Overall, the respondents had the most experiences with interdisciplinarity when teaching in praxis, with 72% of respondents indicating they had opportunities (N=94) and the least experience with teaching in an interdisciplinary way at university, with only 18% reporting they had opportunities to do so (N=23). A frequency graph is presented in Figure 10.

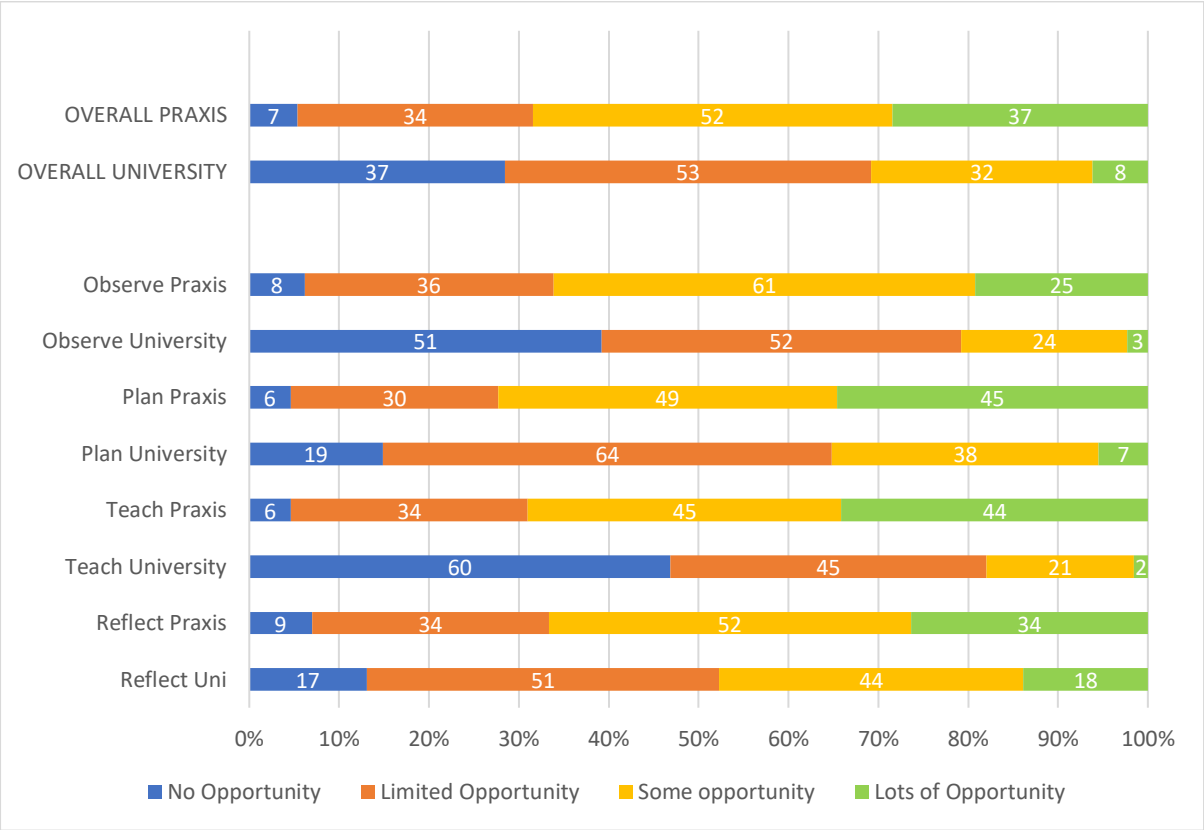
Table 10

Descriptive Statistics of Scales: University and Praxis

Scale	Number	Median	Interquartile Range
University	130	2.2	0.80
Praxis	130	3.0	1.31

Figure 9

Frequency Tables Comparing Praxis & University[3]



Confidence

Overall, the respondents reported high levels of confidence when asked about teaching subjects and using the interdisciplinary themes within and outside their specializations. However, in the interviews, the informants spoke about a lack of confidence working outside their subject-specializations. To see if this was also reflected in the quantitative data, two new hypotheses were created:

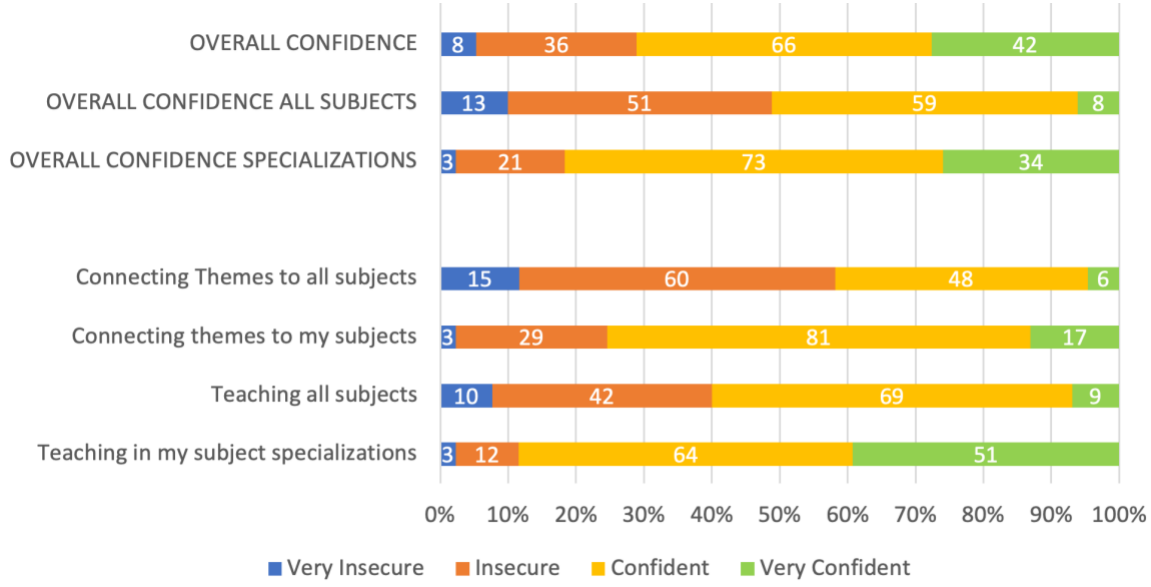
[3] Rounded to the nearest whole percentage

H0: There is no significant difference between how confident prospective teachers feel teaching within and outside of their subject specializations.
H1: There is a significant difference in confidence experienced by prospective teachers when teaching within or outside their subject specializations.

The respondents reported feeling more confident overall teaching and using the themes in their subject specializations (Mdn=3.0, IQR=1) than in all subjects (Mdn=2.5, IQR=1). The Wilcoxon Signed Rank test indicated that there is a significant difference (T=<.001) in how confident the students feel working within and outside their subject specializations. This rejects the null hypothesis, showing that the respondents feel more confident in teaching their subject specializations than all subjects. The frequencies are presented in Table 10, descriptive statistics in Appendix D6.

Figure 10

Frequency Tables Confidence



9.4.2 Qualitative Themes

Subject Specialization in Teacher Education

Due to a focus on professionalization in teacher education, there has been a reduction in the number of subjects the informants could specialize in (Kulbrandstad & Kulbrandstad, 2022). As a result, Aslak claimed they were "forced" to specialize in either Norwegian, English or

Mathematics, and "focus only on these subjects". This appears to have conditioned the informants to believe these three subjects had more value than the others, and to develop a teacher identity connected to their subject specialization. This is explained by Finn who said, "perhaps you think about *your* subjects versus *their* subjects". Interdisciplinarity, despite also being an alleged priority of the government appears to have taken a backseat to deep subject learning. Sara points out this paradox by saying:

> *It hangs a little bit together in the way, I think it is the teacher education, perhaps in a way tried to show that, OK we take a deep focus in subjects, in the way that we can only have two subjects in a five-year education, but, then there is a real focus in the curriculum that it should be interdisciplinary….*

This was frustrating for many of the informants, particularly Sunniva who said,

> *Yes, because I remember that I really wanted to take three or four subjects, but I got the message that I can only take two…. I have heard it is because you are supposed to be really good in your subjects.... I leave university with two main subjects, Norwegian and Physical Education and in five years, this is very little, it's very like, very narrow really…. the pupils have many, many subjects and I just must try and keep up with them.*

This frustration was a consistent theme throughout the interviews. Some informants, particularly Sunniva, Finn and Aslak brought this up several times within their interviews, worrying about how they could teach their pupils effectively or even their employment opportunities. Several of the informants even reported planning on taking future studies in order to be competitive in the job market with Diana claiming it was "because I want to have more subjects". Understandably the idea of taking further education after a five-year degree is incredibly frustrating for the informants, with Sunniva exclaiming, "how many years do I have to go to school to actually teach?!"

Forced Interdisciplinarity

In contrast to the priorities of teacher education, out in praxis schools prospective teachers were required to be flexible, working across grades and subjects, sometimes out of their

specialization areas. Forced interdisciplinarity was experienced by all the informants, causing differing degrees of anxiety. Prospective teachers are new and inexperienced in all subjects, so this anxiety is understandable. Yet this anxiety appeared to be exacerbated by forced interdisciplinarity, increasing *praxis shock*, a term explaining the increased stress of new teachers (Ballantyne & Retell, 2019). The informants, despite all having to specialize in either mathematics, English or Norwegian were teaching all subjects, even German. Three of the informants were required to teach German, one of whom had absolutely no German from before. This was incredibly stressful for Sara. All the informants reported that they would be very unhappy if they were asked to teach subjects where they felt they had no competence, particularly in mathematics and science. The split in terms of subject didactics was once again revealed, with Louise saying she would have to "make a new way of thinking if she was to have mathematics". The separation of subjects appears to have negatively influenced the mind-set of the informants when it comes to working across disciplines.

Apart from the stress, several of the informants feared they would let down their pupils, with Loke saying, "I am afraid they won't get the education they deserve". Finn and Aslak felt like *imposters*, with Finn saying he could teach mathematics, but "wouldn't come away with a sense that he provided learning for his pupils." Several of the informants mentioned that this forced interdisciplinarity has happened to most of their classmates, with them often resorting to YouTube or to put on movies. However, several of the informants were up for the challenge of teaching across subjects out in their praxis periods. Sunniva, Louise and Diana all felt that they became better teachers because of this forced interdisciplinarity, with Diana claiming that "I can work as a casual now in schools, because I normally have subjects which I don't have study points in....and feel that this is something I can do and do a good job."

Sara, was indecisive, saying it really dependent on the subject that she was asked to cover. Her intense dislike of mathematics and gym appeared to have a considerable influence on her attitudes towards interdisciplinary teaching. Like many of the informants, she was open to covering other humanities subjects, feeling that their "didactic map" was more similar to her areas of expertise. The informants all were humanities/linguistic specialists, with only Loke crossing the artificially constructed boundary between mathematics and humanities, taking science and English. Most informants claimed they could *never* have mathematics; they were almost fearful of the subject. They reflected on their own experiences from their schooling and had developed a fixed mindset regarding their mathematical abilities. They believed they were

not good at mathematics and therefore not open to engage with the subject, threatening interdisciplinary collaboration and implementation. This fear of mathematics influenced some of the informants' attitudes towards collaboration with subjects outside of their specializations, or being able to specialize in more subjects, with Sara saying, "well, there are just subjects that I am not interested in, and that's where the challenge lies really". This reluctance continues into their professional practice, with Finn claiming he knew prospective teachers who would see one subject on a job advertisement that "they didn't like, so they wouldn't bother to apply.
However, Louise and Diana were both up for the challenge of teaching all subjects, however they acknowledged that teaching outside of their specialization required a lot more time to prepare, time which they found they did not have in professional practice.

> *I took over a 100% position and I had up to five hours a day and I just did not have time. I realised that I just had to…OK, now I won't bother planning, now I have to try relaxing a bit and gamble that I have the tools to do this. So, I went into a team and knew we should work with Judaism…but I hadn't made a presentation.*

It appears that she prioritized reducing her own stress levels, as opposed to ensuring her quality of teaching. Diana had a similar experience, but like Loke, Finn and Aslak, she was concerned about the capacity she had left to give to her pupils. She looked very stressed when saying:

> *I wouldn't completely feel like I did a good job because I would have to choose much more what I would prioritise. I would have to concentrate on the subjects, and I wouldn't be able to do it to the degree I would like. It would surely mean that I would have less time for the other subjects, less time for the students…*

This sense of responsibility towards their pupils was a predominant theme. The informants feel anxious about having to take subjects that they feel they have "knowledge holes in" (Finn) and are concerned with what they have to bring to the table. While all informants were generally open to different degrees about teaching other subjects, Louise acknowledges that a teacher's self-esteem is a factor, saying, "it's really a bit fun if you have the self-esteem to handle it. I can believe if you don't have the confidence as a teacher, it must be horrible to have to take a subject you don't feel secure in". Aslak believes that this lack of confidence would mean that

new teachers would be reluctant to ask for help or demand their rights for mentorship or the allocated extra planning time, stating, “if you don’t have the confidence, you are not going to demand things”. This forced interdisciplinarity appears to add extra stress to new graduates, and all of the informants expressed the idea of having to prove themselves and rise to the challenges alone, especially considering their higher levels of education and pay (Aslak).

10.0 Limitations of the Study

There are several limitations of this study which must be taken into consideration. Firstly, while considering the perspectives of prospective teachers is important, it does not provide the whole picture. Both the questionnaire and interviews were based on self-reporting data, which can bias the results (Rosenman et al., 2011). To reduce this influence and corroborate results, further studies including faculty and praxis teachers would be useful. Calculating the effect size and confidence intervals and levels are separate analyses which could increase the reliability and validity of this study. However, these were time consuming and difficult to conduct, yet should be part of future analyses.

The quantitative survey was constructed in an exploratory way, both deductively and inductively. Focusing on one methodology would have allowed a deeper focus on one specific aspect of interdisciplinarity (i.e., perceptions) and more items could have been directed towards this single, narrower question. However, this questionnaire, has revealed experiences and beliefs which may not have appeared in a truly deductive survey. While the scales are reliable, it is apparent that including more items relating to each construct, particularly with regards to the smaller scales. At the time of data collection, the only option appeared to be to create my own survey, when it is better to use a pre-established survey to increase validity (Hyman et al., 2006). There is a survey which was recently found (Biseth et al., 2022) and will be used to compare and validate my survey and results in the discussion.

Initially the survey only wanted to ask respondents about their experiences and beliefs regarding interdisciplinarity. After the interviews it became clear that the informants had different and somewhat lacking interdisciplinary understanding. Including an open-ended variable asking the respondents to define interdisciplinarity, would have enabled triangulation with the qualitative data and provided a clear picture, although this would require additional and separate analysis. Using more explicit text in the questions, for example, the question relating to interdisciplinary theory, would provide a better understanding relating to this item.

The questions relating to interdisciplinary experiences with observing, planning, teaching and reflecting needed more items to clarify if the respondents were thinking about interdisciplinary practices, and not just general ones. The 2GLU respondents had just returned from praxis and having engaged in a reflective session, which may have influenced the results.

The informants' perceptions fluctuated through the interviews, as they appeared to have never reflected upon interdisciplinarity and its' implications previously. They considered the interview experience valuable, but this may call the results into question. In most studies the interviews took place post-intervention (see Gombrich and Hogan, 2017). Gombrich and Hogan's (2017) claim that it would be interesting to conduct more studies students who have not experienced interdisciplinary programs, however in this case, it may have been difficult for them to answer honestly, without prior experience or preparation. Giving the informants the questions prior to the interview was considered, but decided against as I wanted spontaneous answers. Parker et al. (2012), also expressed this concern, saying that the informants may have been discussing an unfamiliar discourse. It may be interesting to re-administer the survey post-interview to see how the informants' responses may differ after their reflections.

Due to the standpoint and lack of experience of the researcher, the interviews may have influenced by leading questions or clarifying questions which led to the answers the researcher was looking for. Whilst this was consciously avoided, it may have happened, nonetheless. It was endeavoured to only use excerpts of the data which the researcher considered were of limited bias. It is also a limitation of the study that the interview transcripts have been translated from their original language by the researcher, to avoid this, transcription tools were used, followed by a transcription done by hand. It is worth noting that the voluntary informants only came from the 5 - 10 program, and even though this was the main population being studied, it would have been more ideal to have proportional representation from both groups.

11.0 Discussion

This section will briefly summarise and answer each research question. Data will be presented; however, it is not intended as a re-presentation of results, but to enable discussion regarding the convergence or divergence of the datasets. It will also compare the data collected to the literature, focusing primarily on a recent study by Biseth et al. (2022) who, in similarity to this study, quantitatively examined teacher, prospective teacher and teacher educator attitudes and working methods relating to interdisciplinarity. The Biseth study is part of a bigger project

called BRIDGES, which works to bridge the gaps in teacher education and schools through interdisciplinary work. This study was found after data collection and analysis was completed. Biseth et al. (2022) collected 155 responses from prospective teachers, which is comparable to the 130 responses collected in this thesis. There are comparable questions and results which increase the external validity of the questionnaire used in this thesis. Unlike the BRIDGES study, this study focuses only on the perspectives of prospective teachers and adds a qualitative element to this growing knowledge base. Finally, the discussion will present a new retroductive theory of relevance and a proposal for an interdisciplinary, generalist teacher education program.

11.1. Perceptions of Interdisciplinarity

Prospective teachers appear to have a superficial understanding of interdisciplinarity, predominantly centring on thematic, intra/multidisciplinary teaching and learning. Like in the study by Parker et al. (2012), the informants became more critically reflective towards putting interdisciplinarity into practice, and less idealistic, recognising holes in their professional knowledge. The informants were positive to interdisciplinary approaches in terms of their pupils' motivation or autonomous knowledge construction, this is convergent with the quantitative data, with over 90% of respondents indicating they had interdisciplinarity as a goal of their teaching, and that interdisciplinarity helps develop pupil Bildung. The informants in this study are not alone when it comes to feeling optimistic about interdisciplinarity and its' benefits for learning. In the study by Biseth et al.(2022), more than 80% of teachers feel that interdisciplinarity is "a way of making teaching more relevant for school children and connecting the teaching to challenges in society or the local community" (p.6). Likewise, the prospective teachers in the studies by Parker et al. (2012), Hammond & McCallum (2009) and Kaufman and Grennon Brooks (1996), saw benefits for both pupils and teachers alike, when it came to making sense of curriculum "clutter", pupil engagement, and building understanding from different disciplinary perspectives.

The informants, like the teachers in the BRIDGES study (2022), generally focused on interdisciplinarity as a means to an end, increasing single-subject learning outcomes by making teaching relevant for their pupils and by providing more hooks for knowledge construction. There was very little mention from the informants about how the pupils should work, or the development of 21st century skills for problem-solving, one of the most touted benefits of the interdisciplinary approach (for example, Boix Mansilla, 2005; Newell, 2002). There was no

talk regarding the transference of skills and knowledge between disciplines (Harnow Klausen, 2014) and superficial mention of the interdisciplinary themes. However, the informants were all open to differing levels of interdisciplinary work, something which Gombrich and Hogan (2017) and Spelt et al.(2009) claim is essential, yet disciplinary loyalty, subject segregation and academic self-conceptions appeared to negatively influence their motivation for an interdisciplinary pedagogy. There was an apparent lack of understanding about when a lesson could be considered interdisciplinary, and not just borrowing elements of other disciplines (Benson, 1982) or were a result of a *conceptual spillage* (Klein, 2006), where concepts naturally relate to more than one subject. The informants were also divided when it came to delegating responsibility for implementing the themes and interdisciplinary teaching practices, resulting in frustration for some of the informants.

Interdisciplinarity, with its lack of clear boundaries and criteria, is what Bernstein (1993) would term, an *invisible* pedagogy, with weak criteria. A lack of common discourse, or interdisciplinary pedagogy, is considered a hindrance for its' implementation in Norwegian education (Koritzinsky, 2021; Karseth et al. 2020; Hiis Hauge & Presthus Heggen, 2019; Sinnes & Straume, 2017). This is not isolated to Norway, with Lenoir, Larose & Geoffroy (2000) claiming that their literature analysis on interdisciplinarity, "reveals at best, a hesitation, and at worst, a great confusion about the meaning of the term with reference to its' significance and its' uses. There is no doubt that the word carries ambiguities which obscure its' meaning" (p.90). Like in the studies by Paulsen Dagsland (2021) and Parker et al. (2012), this ambiguity was reflected by the informants. While they could describe a general form of interdisciplinarity where the subjects meld into one another, there was a lack of specificity about what interdisciplinarity meant in terms of pedagogy or didactics. This is perhaps not surprising when considering that "there is no unique interdisciplinary pedagogy" (Klein, 2006 p.6). However, there is a need for a common discourse surrounding interdisciplinarity as it has implications for its' implementation. For example, if multidisciplinarity is the term adopted in the curriculum documents, this would require much less reorganisation of the current pedagogical structures yet still promote collaboration across subjects. Interdisciplinarity implies a much greater level of collaboration and different ways of working, breaking down subject borders and working towards mutual goals as opposed to single subject competencies (FIKS, 2020). This underlines the need for a common discourse to aid the facilitation of appropriate educational structures and experiences and the creation of concrete didactical frameworks. The structure of schools and universities has been mentioned as a considerable obstacle to the implementation of

interdisciplinarity by both the informants and in many studies, for example, Biseth et al.(2022), Paulsen Dagsland (2021) and Dentith et al.(2011).

There have been attempts to define an interdisciplinary pedagogical discourse in the Norwegian context, for example, by Bjørn Bolstad (2020) and the Institute for Research, Innovation and Competency Development in Schools at the University of Oslo (FIKS). In the kindergarten context, Hiis Hauge & Presthus Heggen (2019) have also attempted to provide a clear, theoretical discourse regarding interdisciplinarity. However, the primary source of ambiguity comes from a lack of guidance provided in curriculum documents and textbooks (Andreassen, 2022; Koritzinsky, 2021; Karseth et al., 2020; Sinnes & Straume, 2017; Sundstrøm, 2016).

The Ludvigsen Committee and the Government (Stortinget) disagreed about the role interdisciplinarity should play, and this resulted in a clear prioritisation of single-subject competencies over the interdisciplinary themes (Andreassen, 2022; Koritzinsky, 2021). This disagreement and subsequent prioritization is even indicated in the change of name in the documents, with the Ludvigsen Committee naming their White Paper (2015:8): *The School of the Future*, whilst the related Parliamentary Notice (St.melding §28) is entitled: *Subject-Specialization - Understanding.* This focus on subject specialization resulted in only six lines mentioned about the interdisciplinary themes and the caveat that the themes should only be addressed in the "subjects which they are *relevant*" (Koritzinsky, 2021; Core Curriculum, Directorate of Education, 2017; Sinnes & Straume, 2017, my emphasis). This appears to have led the informants in this study, to believe that the interdisciplinary themes should be primarily addressed by one or two subjects, primarily Norwegian and Social Science. Meanwhile, mathematics appears to be completely left out of the equation by the informants, researchers and in the curriculum (Koritzinsky, 2021), with no studies found in the Norwegian context. The current academic literature also frequently looks at one theme and links it to one subject (see for example, Bae Solvang, 2021; Narvesen, 2019). At best this implies a multi-disciplinary, thematic approach in schools, at worst, this implies that the themes are addressed as competency goals isolated in one discipline. The BRIDGES report (Biseth et al., 2022) indicates the latter, with both practicing teachers and teacher educators reporting they frequently practice interdisciplinarity alone, as opposed to across their programs.

11.2. Interdisciplinarity in the University

Universities, with their strong disciplinary structure (Jacobs, 2017; Turner, 2017) face similar problems when it comes to implementing interdisciplinary practices (Biseth et al., 2022; Vasutova, 1999). The University and College Council (UHR) claims "responsibility for ensuring that the national guidelines for teacher education are *relevant at all times* and contribute to teacher education evolving in line with political priorities and competency needs for the professional fields which prospective teachers are being educated" (2022, my translation and emphasis). The latest guidelines from 2018 claim that teacher education programs must address the universal themes such as: multicultural society, the element of interdisciplinarity is largely left up to individual institutions (Hystad, 2022). In the subject-specific guidelines for teacher education, there appears to be no apparent requirement that interdisciplinary connections or teaching should be a focus.

A lack of focus in both the teacher education guidelines and curriculum documents appears to translate to interdisciplinarity not being prioritised in university, with both the informants and respondents reporting little opportunities to work with interdisciplinarity. The respondents in the study by Biseth et al. (2022) only 10% of prospective teachers reporting that they worked with interdisciplinarity to a great extent. In this study, the percentage was even smaller, 5.75%. Since the respondents indicated less opportunities to observe, plan or teach in an interdisciplinary way, it seems contradictory that they would report more opportunities to reflect. However, this may also confirm the findings of Canrinus et al. (2018) who found prospective teachers had little opportunities to examine classroom situations yet reported more opportunities to reflect and plan for teaching. This could also indicate that the respondents were thinking about general reflection on their professional practice, as opposed to on interdisciplinary teaching. This may be more relevant considering that 2GLU had recently had an extensive reflection session post-praxis; however, further clarification is needed.

In the BRIDGES report, prospective teachers perceive less interdisciplinary instruction than the teacher educators claim they provide (Biseth et al., 2022). This may be confirmed in this study, by an observed interdisciplinary lesson in 2GLU which none of the informants could recall in the interviews, even when prompted. As Canrinus et al. (2017) point out, the intended curriculum is not the received curriculum, reinforcing the need for student perspectives in curriculum design. This may support the claim of the informants, who say that, while interdisciplinarity has been addressed in pedagogy, it was superficially done. They attributed

this to the "fullness" of pedagogy. This is not surprising given all the previously outlined themes they are required to cover, in addition to other universal topics, such as learning theories.

However, both the respondents and the informants claimed high levels of familiarity with the interdisciplinary themes (81%, N=105). This is higher than the respondents in the BRIDGES study who correspondingly reported 63%. (N=98). Yet, it must be kept in mind that this is self-reporting data, which may show a lack of critical insight into ones' own abilities (Fidalgo-Neto et al. 2013). This was potentially illustrated in the interviews where, despite their claims of familiarity, none of the informants could recall the names of the three interdisciplinary themes or connect them to all subjects. Additionally, this was reflected in another section of the quantitative data, where the respondents indicated a much lower confidence level when connecting the interdisciplinary themes to subjects outside of their specializations as opposed to within.

In addition to a lack of room in pedagogy, the informants strongly cited a lack of program coherence and increased subject specialization as detrimental factors for interdisciplinary teaching and learning in university. This is corroborated by the BRIDGES study, in which prospective teachers report "a lack of interdisciplinary collaboration between subjects" (p.9). However, this lack of coherence is not as evident in the quantitative items, except for the variable "the teachers refer explicitly to other subjects". This is divergent to the qualitative data where the informants could only recall very few occurrences where the subjects referred to one another, with one informant referring to pedagogy and subject-didactics as "two separate programs". This structural segregation may mean that there is a lack of an arena for interdisciplinary curriculum planning and implementation to take place. This is despite the National Guidelines claiming that "in the teacher education programme, pedagogy and pupil-related skills, teaching subjects and teaching practice shall be linked closely together in a way that ensures coherence and progress in the education" (National Guidelines, 2018 p.7). Program coherence is not only necessary for interdisciplinarity, but for providing prospective teachers with the best education possible to prepare them for their professional practice, reinforcing visions of desired pedagogical and didactic strategies (Choo Goh et al., 2020; Canrinus et al., 2019; Hammerness, 2013; Darling-Hammond et al., 2005).

While coherence may assist in promoting interdisciplinarity, interdisciplinarity may be the key to increasing program coherence by enforcing collaboration across the disciplines, with

Karppinen et al. (2013) claiming that "integrative teaching is one way of confirming interaction between students, between a teacher and students and between teachers from different disciplines" (p.149). However, this requires teacher educators unanimously working towards a common goal, not only focused on their subjects (Hammerness, 2013).

The informants claimed that the subject teachers prioritised content over didactics. Despite being ten years old, this is consistent with the findings of Hammerness (2013) who reported deep segregation between pedagogical subjects and subject-didactics. She found that subject-didactics teachers were more preoccupied with their subjects than connecting theory to practice (Spalding, 2002; Siskin, 1994). Specialising in fewer subjects (Kulbrandstad & Kulbrandstad, 2022) appeared to enhance the informants' disciplinary loyalty (Chan, 2004) and development of a subject-linked identity. Like the studies by Sinnes and Jegstad (2011) and Meister and Nolan (2001), this also made the informants more sceptical to interdisciplinarity when it involved them working outside their areas of specialization. It was interesting to observe that this subject identity appeared strongest in the 5th year males, who appeared to be the most reluctant to teach outside of their disciplines. However, the reason was that they were more pre-occupied by the quality of their teaching, as opposed to the female informants from 5GLU, who indicated they were more likely to "wing-it" or go in unprepared. The informants expressed that their didactic "maps" were not transferrable between subjects, and at times expressed that their understanding of interdisciplinary didactics was lacking.

Didactics are a primary way of connecting theory to practice focusing on the relationship between the content, teacher and the pupil (Midtsundstad & Willbergh, 2010). Bjørg Brandtzæg Gundem (2011), talks about three forms of didactics, known in Norwegian as, almendidaktikk, fagdidaktikk og didaktikk. Loosely translated, they refer to pedagogy, subject didactics and general didactics. As previously discussed, pedagogy functions as an *umbrella*, focusing on overarching concepts such as, a multicultural classroom. Meanwhile subject didactics, focuses on content and didactics relevant to that discipline. However, according to the informants, didactics was generally absent, with a primary focus on content. While didactics in the German tradition relates to a commitment to Bildung, matter/meaning and autonomy (Midtsundstad & Willbergh, 2010; Hopmann, 2007), the informants appeared to express wishes for a more Anglo-American form of didactics, focused on curriculum and direct instruction (Werler & Tahirsylaj, 2022). The fifth-years claimed that Bildung-related didactics were too vague and abstract (høysvevende), to be considered relevant. This was a complaint of

almost all of the informants and some of the respondents, expressing a desire for more explicit didactic methods, both generally and specifically relating to interdisciplinary teaching and learning. This is also consistent with the findings of the BRIDGES study (2022) and Høgheim & Jenssen (2022). Hammerness (2013) found that Norwegian universities were reluctant to teach explicit didactics, however it is necessary if interdisciplinarity is going to be successfully implemented in schools (Borromeo Ferri, 2016; Hammond & McCallum, 2009; Klein, 2006; Kaufman & Grennon Brooks, 1996). Without consistent reinforcement throughout teacher education, which is currently not occurring, prospective teachers risk entering the profession "without the tools nor sufficient content to address the three interdisciplinary topics" (Biseth et al. 2022, p.10; Koritzinsky, 2021). It is unrealistic to expect an unknown pedagogy to be implemented by newly graduated teachers (Kaufman & Grennon Brooks, 1996), particularly when we consider their experiences in praxis.

11.3. Interdisciplinarity in Praxis

The quantitative results indicate that the respondents had significantly more experience with interdisciplinarity in praxis than in university (70%, N=91). The qualitative results were convergent, with five out of seven informants claiming to have had interdisciplinary experiences in praxis. This also appears to corroborate with how practicing teachers reported their own interdisciplinary practices in the BRIDGES study (80%, N=725). One weakness of the BRIDGES study is that there is no examination of the nature of experiences student teachers have had in university and praxis, however, this thesis may shed some light on this.

It could be claimed that none of the informants actually had an authentic interdisciplinary experience out in praxis. The experiences in praxis were generally all at an intra- or multidisciplinary level, with strong divisions still in place between the subjects and subject-teachers. Klein (1990) describes this form of interdisciplinarity as *additive* rather than *integrative* where the teachers still retain their disciplinary identity where, “even in a common environment, educators, researchers and practitioners still behave as disciplinarians with different perspectives" (p.56). While one could argue that Sunniva with her math-inspired Norwegian lesson is an example of interdisciplinarity, it is actually a form of *pseudo-interdisciplinarity* (Lenoir et al., 2000), as it did not initiate any transference of skills between the disciplines, nor did it enable innovation or pupils to build on their knowledge in a way which requires two disciplines (Boix Mansilla, 2005). Teacher collaboration does not necessarily correspond with interdisciplinary work for pupils, with Bernstein (1999) stating,

that "what is acquired in one segment or context may bear no relation to what is acquired or how it is acquired in another segment or context", without being united under a "co-ordinated principle" (p.160). The informants provided examples where pupils are learning about the same theme for a day or a week, however there was no apparent transference of skills between the disciplines, or subject acknowledgement of other disciplines by the teacher/s. The informants spoke of a lack of knowledge or hesitance stemming from the praxis teachers, which is consistent with the findings of Ryu et al. (2018), who found that prospective teachers felt they lacked good role models for interdisciplinarity out in praxis. Teachers themselves desire more professional development on how to work in an interdisciplinary manner (Paulsen Dagsland, 2021; Rikardsen Jaatun, 2022; Hansen, 2020). They, like the informants, emphasize that they are pushed to focus on "subject, subject, subject" leaving little time for interdisciplinarity (paraphrased from Paulsen Dagsland, 2021 p.39).

Hammond & McCallum (2009) found that when prospective teachers learned about interdisciplinary teaching and learning in their teacher education, this followed them out into their professional practice. While the informants in this study have not graduated, it seemed they too have been influenced by their experiences in praxis. After observing multidisciplinary approaches in schools, they defined interdisciplinarity as multi-disciplinarity, with subjects segregated. They were open to teaching in a multidisciplinary way, yet it is *inter*disciplinarity included in LK20. In the majority of cases reported by the informants, cross-curricular work was a one-time occurrence, as opposed to being integrated into the curriculum as the Ludvigsen Committee intended it to be (Koritzinsky, 2021). This is also consistent with the findings of the BRIDGES report, who reported that even though teachers engaged with interdisciplinary work, this happened only occasionally.

As none of the informants reported taking part in frequent or authentic interdisciplinary experiences, it may be considered unlikely these can be implemented in their future professional practice. Vasutova (1999) claims that prospective teachers may attempt to "ease" themselves into the profession, by adopting the same teaching demonstrated by their mentors. The informants already mentioned time constraints, without taking interdisciplinary planning into consideration. Like the Parker et al. (2012) study, this was something the informants considered more advanced, requiring more time and resources for collaboration. This may imply that only a type of obligatory pseudo-interdisciplinarity (Lenoir et al.,2000) will be implemented.

Koritzinsky (2021) raises an important question, "does this interdisciplinary breadth come at the expense of deep learning?"(p.27). Currently, with the examples presented in the interviews, one can assume this to be the case. According to the informants, it appears that many practicing teachers may need more professional development, not in terms of subject-specialization but with developing a mutual understanding of interdisciplinarity. Teachers also require concrete strategies (Borromeo Ferri, 2016) on how to include the three interdisciplinary themes in a sustained, meaningful way, as opposed to a week or day of obligated "interdisciplinary" teaching reported by the informants. This will enable interdisciplinarity to be ingrained throughout the curriculum as the Ludvigsen Committee intended (Koritzinsky, 2021). As discussed, interdisciplinarity in elementary education lacks a common discourse, or what Hopmann (2003) terms, "a stable frame of reference" (p.469). Interdisciplinarity can promote deep learning (Warburton, 2003) yet a lack of concrete pedagogy appears to lead both prospective and practicing teachers to see interdisciplinarity “as secondary to discipline-based approaches" (Cartese, 1992; Dyer, 1997 in Warburton, 2003 p.44).

However, there is also internal conflict for teachers, attempting to balance the development of core competencies, such as reading, together with innovative teaching practices such as interdisciplinarity. Joe Garcia (2001) describes this conflict, claiming that teachers agree upon a "need for disciplinary competence" but additionally a need for "systematic rethinking of practices, a view of interdisciplinarity as something to be applied, and emphasis on the role of shared projects, collective work, and integration of disciplines" (in Klein, 2006 p.12). This dilemma between disciplinary competence and integration of disciplines was visible in the interviews, but also in the quantitative data, where 90% of respondents claimed to be open to interdisciplinarity, yet approximately half of them indicated they only wanted to teach within their specialties, and also believing that subject borders were good to have. This may also indicate that the respondents were only open to a multidisciplinary form of interdisciplinarity, remaining safely ensconced in their disciplines.

11.4. Comparison between University and Praxis

The findings demonstrate, in likeness with the BRIDGES study, that there is more implementation of interdisciplinarity in schools than in teacher education. Despite this the informants perceived several significant obstacles to interdisciplinary teaching in schools: teacher attitudes and/or lack of competence, institutional structure and time pressure,

accountability, and a predisposition for traditional teaching methods. While they were referring specifically to a school context, these topics are also relevant for university.

However, the biggest contrast between university and praxis appears to be the requirements of subject specialization in university, as opposed to the interdisciplinary demands of praxis. Both Koritzinsky (2021) and Spanget Christensen and Hobel (2014) point out the political paradox of demanding focus on core subjects while simultaneously introducing interdisciplinarity. This paradox was also brought up by one of the informants. This was a source of frustration for the informants, most of whom wanted to specialise, or at least gain competency in more subjects. The National Guidelines for Teacher Education acknowledge that "schools require teaching staff with broad competence. Because of this, and out of consideration for students' opportunity for mobility throughout the programme, institutions are expected to provide a wide range of subjects" (National Guidelines 5 - 10, 2018, p.7, my translation). Yet, they still specify a high number of credit points required for accreditation in each subject, limiting opportunities for prospective teachers to be qualified in more subjects (Kulbrandstad & Kulbrandstad, 2022).

In contrast, a lack of time and resources in schools resulted in the informants having to teach outside of their areas of specialization in praxis. This had diverse impacts on the informants, some of whom relished the challenges and others who experienced anxiety or exacerbated *praxis shock*, feeling that the quality of their teaching was not good enough and would let down their pupils. This was also reflected by the informants who felt okay teaching across disciplines. They felt they did not have adequate time to prepare, or this preparation would come at the cost of their relationships with their pupils and/or the quality of their teaching. This replicates the findings of Antonsen et al. (2022) who found that elementary teachers had to teach up to four subjects outside of their specializations. Like this thesis, the authors found that new teachers in their specialization felt a sense of mastery and motivation and could experiment didactically, however when working outside of their specializations, they were forced to use time and energy in learning subject knowledge and didactics but ended up experiencing inadequacy anyway.

For the informants this anxiety fluctuated again depending on the subjects the informants were required to teach. Mathematics and German sparked the most anxiety, whilst the other humanities subjects were less so. The quantitative results indicate divergence, with the respondents reporting high levels of confidence in teaching all subjects and connecting the themes to their subject specializations. There may be a difference between hypothetical talking about teaching other subjects than actually being forced to do so. When talking to the

informants, a couple of the fifth-years expressed that their anxiety was exacerbated by the pressure of being the first graduates from the newer, longer, more profession-oriented program (Kulbrandstad & Kulbrandstad, 2022). In particular the fifth-years indicated they felt like frauds or imposters, wondering if they would have anything relevant to contribute to their future schools.

11.4. The Relevance of Teacher Education

Vasutova (1999) talks about teacher education in the Czech Republic being criticized for sending out new teachers unprepared for the realities of everyday life, finding that "graduates of teacher training programmes are often disappointed at the beginning of their teaching career and even during their first experiences with the reality of school teaching practice. It seems that prospective teachers do not have the necessary knowledge and skills" (p.210). Norwegian teacher education has faced the same criticism, with claims from both prospective teachers and researchers alike. A Norwegian article by Svarstad (10th of December 2020) interviews a prospective teacher who claims, "my [teacher] education is a crisis, I'm not being taught how to be a teacher!" (author translation). The article also cites a NOKUT study (Studiebarometeret) from 2018, which found that prospective teachers are some of the least satisfied with their education. Claims of a lack of relevance have also come from researchers, with Biseth et al., (2022) claiming that teacher education is "not teaching relevant content and, hence, contributing to schools' challenges to teach for future needs" (p.1). The topic of relevance also was a theme which permeated through both datasets, with both informants and respondents desperate for presentation of appropriate theory, didactics and practicality in their education. A recent quantitative study by Høgheim and Jenssen (2022) asked GLU students about their perceptions of their teacher education, finding "a perceived of lack of professional relevance in the on-campus lectures, the teacher educators' competence, and communication" (p.5). This was also the impression given by the fifth-year informants and respondents in the open-ended variable. This has consequences, with Hollup and Sommer Holm (2015) finding that a lack of relevant education led newly educated teachers to leave the profession. Again, this was reflected by one fifth-year informant who claimed that an intense focus on content and lack of didactics led a quarter of her class to leave the program.

The discussion on relevant teacher education could span in many directions, yet the focus of this thesis is on interdisciplinarity and the disconnect between the requirements of the curriculum and professional practice versus what is being experienced in teacher education.

Currently there appears to be a big disconnect, with the informants claiming few experiences with interdisciplinarity in university and required subject-specialization, as opposed to the demands for interdisciplinary teaching and didactics in praxis. This disconnect has led to the development of a tentative theory which relates to how perceived relevance influences the introduction of interdisciplinarity.

11.5. Retroductive Theory of Relevance

The abductive method requires examining anomalies, unexpected findings or trends in the data and attempting to explain them with probable conclusions (abduction) and generate tentative theory (retroduction) (Proudfoot, 2022). This thesis focuses on how interdisciplinarity is experienced in teacher education and based on the findings, this appears to be heavily influenced by the relevance which is attached to interdisciplinarity within each element of teacher education throughout the pedagogical discourse. I will use Basil Bernstein's (1996) theory of the pedagogical discourse to base my own Theory of Relevance and its' influence on the implementation of interdisciplinarity (see Figure 11). Bernstein's pedagogical discourse comprises of three primary levels: the Regulative Discourse, the Field of Recontextualization and the Instructional Discourse.

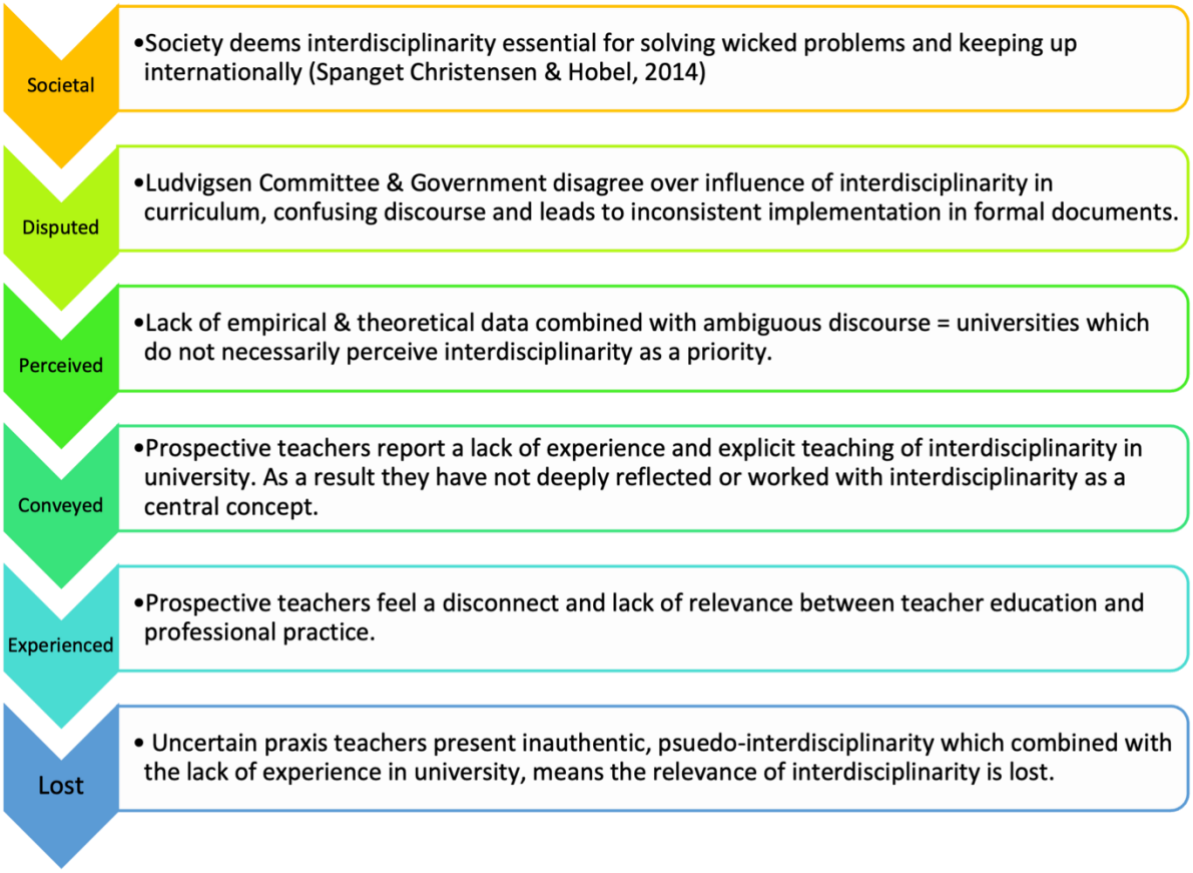
The Regulative Discourse dictates pedagogical practice, based on societal demand and political priorities (Bernstein, 1996). In this context, the regulative discourse comprises of the Government and the Ludvigsen Committee who have determined that, based on *societal relevance*, interdisciplinarity should be a component of the new curriculum. However, as discussed, there was disagreement over the extent to which interdisciplinarity should be included, with the Ludvigsen Committee feeling interdisciplinarity should permeate the curriculum in its' entirety, whilst the Government feared the loss of subject specialization (Koritzinsky, 2021; Karseth et al. 2020). This *disputed relevance* has led to a lack of common discourse and thorough implementation in curriculum documents (Sinnes & Straume, 2017) and in teacher education guidelines (Hystad, 2022).

The university is the conduit between the regulative and instructional discourses, recognising what is important in terms of governmental priorities and recontextualizing them in a manner which can be realised by the instructional discourse in schools (Bernstein, 1996). The lack of clear discourse and a lack of theoretical and empirical data relating to the success of interdisciplinary teaching (Xu et al.,2022) may influence teacher education programs and

faculty towards a lack of *perceived relevance* of interdisciplinarity in either tertiary or school contexts.

Figure 11

The Types of Relevance and Interdisciplinarity in the Pedagogical Discourse



Subsequently, prospective teachers in this study and the BRIDGES study (Biseth et al. 2022) have indicated a lack of experiences with interdisciplinarity in university and even less teaching of explicit interdisciplinary didactics. This may result in a lack of *conveyed relevance* to prospective teachers, who need to experience a coherent teacher education program, promoting a vision of good teaching (Hammerness, 2013), as well as the development of desirable teaching strategies (Darling-Hammond et al. (2005). The informants expressed a lack of *experienced relevance* between their course and their profession, with the focus on subject-specialization contrasting strongly with the requirements for two types of interdisciplinarity in praxis: working with the interdisciplinary themes and working outside subject specializations.

The Instructional Discourse comprises of schools and teachers who are responsible for implementing the curriculum. It is their job to *recognise* what is important in the curriculum and *realise* its' implementation (Bernstein, 1996). The informants reported only few experiences with interdisciplinarity out in praxis, albeit much more than they have experienced in university. However, the quality of these experiences can be brought into question. Like the informants in the Ryu (2018) study, the informants reported a lack of knowledge and comfort with interdisciplinarity from their praxis teachers, who often presented interdisciplinarity as superfluous to requirements, requiring extra time and effort which the informants felt they did not have. The pseudo-interdisciplinarity experienced by the informants meant that they have not experienced an authentic, effective interdisciplinary pedagogy, potentially negatively influencing how prospective teachers perceive and practice interdisciplinarity. Incorrect implementation of interdisciplinary teaching and learning will lead to *lost relevance*, resulting in, what Sinnes & Straume (2017), term "business as usual" in schools. These findings and theoretical set of observations indicate that changes may be required throughout the pedagogical discourse, from policy to practice.

11.6 Proposal for Change

While Biseth et al.(2022) call for transformative, relevant changes in teacher education, one may question if it is possible, given the dominant, dormant structure of disciplines. This is not a new problem, with the CERI Report (1972, p.220) asking:

> *How can a reform so thorough and varied in its' requirements and forms be accomplished? It must be realised that little progress will be made so long as new methods of operation as well as new operators have not been selected or set up. In other words, introducing interdisciplinarity into the Universities involves both a profound change in teaching methods and a new type of teacher training, the whole being governed by a change of attitudes and faculty-student relationships.*

Biseth et al.(2022) claim that "methodological knowledge about interdisciplinary teaching methods [is] where the gap between teacher education and school is most clearly experienced" (2022, p.9). However, this thesis doesn't find this gap as such, there appears to be more of a mutual confusion surrounding interdisciplinarity which requires clarification. Based on the feedback from the informants based on their experiences in university and praxis, it appears the "gap" lies, predominantly within the regulative discourse, who appear divided between the

prioritization of single-disciplinary competence (Kulbrandstad & Kulbrandstad, 2022) and the simultaneous expectation of interdisciplinarity (Biseth et al., 2022; Koritzinsky, 2021). Here, the government have half-way selected a new "method of operation" but not followed through as the authors of the CERI Report (1972) claim is necessary.

Interdisciplinarity appears to drown in universities and schools which already exist in entrenched disciplinary structures. Considering this, it may be more logical for Norway to adopt a multi-disciplinary approach, like Finland (Mård and Hilli, 2022) than to continue down a more demanding interdisciplinary road. Interdisciplinarity, to a greater extent, challenges disciplinary structures and the boundaries of knowledge, making it easier to overlook, than to alter the status quo (Turner, 2017).

The quote from the CERI Report (1972) highlights a need for "profound change in teaching methods and a new type of teacher training" (p.220), while Biseth et al. (2022) call for transformative reform. This may only be achievable if we alleviate the stranglehold that disciplines appear to have on tertiary education (Turner, 2017). Not only for the sake of interdisciplinarity, but in order to recruit, prepare and retain prospective teachers in the profession, which is currently a pressing issue (Strand & Tønnesen, 2023). As opposed to the new, research-oriented 5-year study, I propose a new structure to teacher education, returning to profession-oriented education where primary and middle-school teachers are educated as generalists, not specialists (Table 11).

It is common practice in many parts of the world (Beudels et al., 2021) which may help to holistic prepare prospective teachers for the demands of the workplace. Generalist education could potentially reduce the fear of other subjects, and prospective teachers could develop a sense of identity focused on their teaching, rather than locked into a discipline (Spalding, 2002). According to Beudels et al. (2021), primary school educators, like the sample groups of this study, are more likely to cite pedagogical reasons for choosing to become a teacher, as opposed to disciplinary preferences, which may make primary education programs more suited to an interdisciplinary approach in university. Klein (2006) claims that interdisciplinarity " must not be peripheral to teacher training at all points of the career life cycle" (p.16), while the Ludvigsen Committee desired the three interdisciplinary themes to be ingrained in all aspects of the curriculum (Koritzinsky, 2021). These desires point to a need for interdisciplinarity to become naturalized, much like COVID-19, no longer a novelty or danger, but something with which we become accustomed to living with and using. Interdisciplinarity may enable

innovative, democratic teaching and learning (Newell, 2002), but in terms of teacher education, this requires an increased focus on interdisciplinarity, to *override* our prior experiences with school (Grossman, 1991).

Table 11

Proposed Interdisciplinary Teacher Education Curriculum

Year	***Subject-Didactics***	***Pedagogy***	***Research***	***Interdisciplinary Didactics***
1	Academic Writing Norwegian	Intro to PED: Learning Theory & Curriculum	Intro:Research Methods	Intro to ID Curriculum & Pedagogy
2	NOR or English	Behaviour Management	Educational Technology	Democracy& Citizenship
3	Math or Science	Curriculum Planning	QUAN+QUAL research Methods	Health & Life Skills
4	KRLE or Humanities	Differentiation & Special Education	ID Research & Reflective Practice	Sustainable Development
5	Creative Arts or Physical Education	Professional Communication	Master Class	Master Thesis

Inspired by the curriculums of Gombrich and Hogan (2017), Dentith et al. (2011) and Hammond & McCallum (2009), this new teacher education would have an explicit focus on developing interdisciplinary knowledge and skills. Like the three values guiding the interdisciplinary curriculum of Hammond and McCallum (2009): sustainability, social justice and democratic process (p.53), the three interdisciplinary themes: Sustainable Development, Health & Life-Skills, and Democracy & Citizenship represent a good starting point for developing interdisciplinary understanding. While Biseth et al.(2022) claim these could be omitted from teacher education, the ambiguity surrounding interdisciplinarity implies that there is a need for a transparent and consistent framework on which to build interdisciplinary understanding in universities and schools. Warburton (2003) asks if there could be a "new academic "discipline" for trans-disciplinary studies to consider effective ways to translate, reconcile and integrate disparate discourses, traditions and methodologies?" (p.44). The three themes may form the foundation of the academic discipline Warburton is looking for. The three

interdisciplinary themes are designed as overarching subjects which can engage prospective teachers in longer term interdisciplinary planning, pedagogy and didactics, something which all of the informants desired. Darling-Hammond et al. (2005) claims that "learning ideas within the context of an overarching conceptual framework not only helps students understand the "big picture" but also enables them to recognize how all the individual ideas and theories fit together and relate to one another" (p.397). By using the interdisciplinary themes as an overarching conceptual framework, prospective teachers will be able to familiarise themselves, not only with the themes themselves, but with different disciplines and interdisciplinary pedagogy. It will also require that faculty across different subjects work closer together, increasing program coherence (Karppinen, 2013). Familiarising prospective teachers with content knowledge from various disciplines and how they can connect to the interdisciplinary themes will mean that they are better equipped to implement interdisciplinarity in their professional practice (Hammond & McCallum, 2009; Santaolella et al., 2020) and more confident to engage with other disciplines (Beudels et al., 2021; An, 2016; Björkgren, Gullberg & Hilli, 2014; Kaufman & Grennon Brooks, 1996). Engaging with interdisciplinary related pedagogy such as problem-based or inquiry learning (Mebert et al., 2020; Stentoft, 2017) will help to develop prospective teachers interdisciplinary understanding and skills, ultimately increasing their overall interdisciplinary integration ability, the learning outcome described by Xu et al. (2022) and Spelt et al. (2009). While promoting more generalised subject knowledge, prospective teachers are forced to cross the "taboo" border between the humanities and sciences (Gombrich & Hogan, 2017). While the 1 - 7 program currently requires both Norwegian and Mathematics, this is not a requirement in 5 - 10, and appeared to have a big impact on how the informants were (un)willing to engage with mathematics. An academic writing course would help new prospective teachers adapt to university life, but also learn to write scientific and social-science formats. This was found to enhance interdisciplinary understanding in a study by Arneback and Blåsjö (2017). A transdisciplinary approach using the three interdisciplinary themes as an umbrella for all of the teaching in teacher education could also be a successful approach, yet this would require more restructuring of the university's structures and as such, is less feasible than the approach presented here.

This curriculum may gain criticism for not having a deep enough subject-specialization; however, it is the intention to provide a generalist education where teachers are able to work across subjects adequately and confidently from grades 1 - 10. The prospective teachers would gain familiarity with more subjects and working with the Master Class (a preparation for the

thesis), Master thesis and three interdisciplinary theme subjects would provide additional opportunities for working with the disciplines, specializing if desired. Developing disciplinary knowledge through interdisciplinary understanding is what the informants saw as one of the main benefits of interdisciplinarity, there is no apparent legitimate reason why this would not work for prospective teachers too.

In this new curriculum, pedagogy has been redesigned to be more relevant based on informants' wishes indicated in both the quantitative and qualitative data and reflected in the studies by Biseth et al.(2022) and Høgheim and Jenssen (2022). These topics addressed in pedagogy are relevant in any discipline and may help increase coherence between university and praxis. This is already the aim in pedagogical subjects (National Guidelines, 2018); however, these topics are developed based upon the feedback from the participants who perceive these would be useful. An increased focus on didactics in teacher education may help prospective teachers feel more confident when it comes to teaching, constructing a beginning repertoire on which to build future practice (Hammerness, 2013). This may also help prospective teachers to see the relevance of what they are learning, again enhancing the connection between theory and practice (Darling-Hammond et al., 2005). While one may argue that the praxis school is the best place to practice new teaching strategies, Darling-Hammond et al. (2005) cite Ball and Cohen (1999), saying that *authenticity* of learning activities is more important than the location. They claim that while a school environment may be considered more authentic, it is more chaotic and requires prospective teachers to act in the moment, without being able to focus on the pedagogical strategy they are trying to master. The university may provide an environment for prospective teachers to build this repertoire, provided that the learning experiences are facilitated in such a manner that enables scaffolded, controlled interdisciplinary instruction to occur.

Common learning opportunities which occur across university and praxis schools may enable prospective teachers to see the relevance of their learning and create their own experiences with interdisciplinarity before entering the profession. Two studies by Santaolella et al. (2020) and Kaufman & Grennon Brooks (1996) involved prospective teachers actually implementing their interdisciplinary plans in schools and the community, something which Kaufman & Grennon Brooks (1996) claim enabled "teacher candidates [to] explore their professional growth as confident and competent teachers through inquiry and discovery in the fieldwork" (p.244). Yet it is essential that these experiences are reflected upon in praxis, and this is something which

was lacking according to the quantitative data. Reflective teacher practice is essential for professional development and to develop best practice with D´Souza et al. (2021) referring to reflective practice as the "responsibility for contemplating teachers' practice, what they do, why they do it, and how they do it, inside or outside the classroom, in order to make the practice significant" (pp.10-11). Common learning experiences between the university and praxis schools may also facilitate professional development of practicing teachers, empowering them to become better mentors in terms of interdisciplinary teaching and learning, and improving its' implementation in schools.

12.0. Conclusion

While the respondents and informants have positive attitudes to interdisciplinarity, these opinions may be anchored in ideology, rather than experience. This assumption is based on the limited experiences the study participants reported having in university, and the nature of experiences the informants recalled from praxis, where few, if any, had an authentic, sustained interdisciplinary experience. Based on the findings of this study, it is a probable conclusion that interdisciplinarity will not be successfully implemented in schools. In line with abductive reasoning, this conclusion is only tentative and based on the information at hand, which is incomplete (Mitchell, 2018). This conclusion comes, not intended as a criticism of the educational system which currently prevails, but as observations which may be useful to act upon if interdisciplinary education is to be prioritised. Its' implementation requires that prospective teachers and those who teach them, have a clear understanding of interdisciplinarity, not only its' benefits, but a conceptual and didactical framework (Borromeo Ferri, 2016). However, more research is needed, with this thesis being only one of a few explorative studies on interdisciplinarity in teacher education. Both cross-sectional and longitudinal research may help develop a better understanding of how practicing and prospective teachers understand, experience and practice interdisciplinarity and evaluate the success of any interdisciplinary intervention or curriculum reform. Like Xu et al. (2022) suggest, there is a need for empirical data relating to the success of authentic interdisciplinary teaching. This is needed to justify interdisciplinarity as a valid pedagogical approach and to assist in developing a concrete conceptual framework (Mård and Hilli, 2022) and common discourse (Klein, 2006), which then can be recontextualized into sufficient curriculum and criteria for schools (Koritzinsky, 2021; Sinnes and Straume, 2017). This implies that further,

intervention-based, longitudinal studies, like Hammond and McCallum's (2009) are needed, both within teacher education and in schools.

One may question, with the lack of empirical support for interdisciplinarity and the enormous undertaking of restructuring well-established educational institutions and mind-sets of educators and prospective teachers, is it worth it? But interdisciplinarity for interdisciplinarity's sake is not necessarily the only goal. Disillusioned prospective teachers (Høgheim & Jenssen, 2022) and decreasing applications for teacher education (Strand & Tønnesen, 2023) are indicators of a profession in trouble, with Hollup & Sommer Holm (2015) citing SSB saying there will be a deficit of 38,000 teachers in Norway by the year 2025. Interdisciplinarity in teacher education may be considered a way of increasing perceived relevance to professional practice, as well as program coherence, by forcing collaboration (Karppinen et al., 2013). Implementing interdisciplinarity in teacher education and schools may also result in reducing teacher isolation, increasing teacher autonomy and a sense of professionality and may encourage practicing teachers to remain in the profession (Petroelje Stolle & Frambaugh-Kritzer, 2014).

The structure of our educational system has existed since medieval times (Klein, 1990). Perhaps interdisciplinarity can be the "innovation of the 21st century university" as Frodeman (2017, p.6) describes, reinvigorating teacher education. However, this will require an alignment of priorities throughout the pedagogical discourse. Teacher education, as the main conduit between policy and practice plays a pivotal role in the implementation of interdisciplinarity and needs to lead the way, developing a common discourse and demonstrating successful interdisciplinary pedagogy.

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Appendix A: NSD Approval & Consent Form

Sikt

Meldeskjema / Coherence and interdisciplinarity in teacher education / Vurdering

Vurdering av behandling av personopplysninger

Referansenummer Vurderingstype Dato 145270 Standard 15.09.2022

Prosjekttittel
Coherence and interdisciplinarity in teacher education

Behandlingsansvarlig institusjon
Universitetet i Agder / Fakultet for humaniora og pedagogikk / Institutt for pedagogikk

Prosjektansvarlig: Esther Canrinus

Prosjektperiode
30.09.2022 - 15.06.2024

Kategorier personopplysninger
Alminnelige

Lovlig grunnlag
Samtykke (Personvernforordningen art. 6 nr. 1 bokstav a)

Behandlingen av personopplysningene er lovlig så fremt den gjennomføres som oppgitt i meldeskjemaet. Det lovlige grunnlaget gjelder til 15.06.2024.

Meldeskjema

Kommentar
ABOUT OUR ASSESSMENT
Data Protection Services has an agreement with the institution where you are carrying out research or studying. As part of this agreement, we provide guidance so that the processing of personal data in your project is lawful and complies with data protection legislation.

We have now assessed the planned processing of personal data in this project. Our assessment is that the processing is lawful, so long as it is carried out as described in the Notification Form with dialogue and attachments.

IMPORTANT INFORMATION

You must store, send and secure the collected data in accordance with your institution's guidelines. This means that you must use online survey, cloud storage, and video conferencing providers (and the like) that your institution has an agreement with. We provide general advice on this, but it is your institution's own guidelines for information security that apply.

TYPE OF DATA AND DURATION

The project will process general categories of personal data until 15.06.2024.

LEGAL BASIS

The project will gain consent from data subjects to process their personal data. We find that consent will meet the necessary requirements under art. 4 (11) and 7, in that it will be a freely given, specific, informed and unambiguous statement or action, which will be documented and can be withdrawn.

The legal basis for processing general categories of personal data is therefore consent given by the data subject, cf. the General Data Protection Regulation art. 6.1 a).

PRINCIPLES RELATING TO PROCESSING PERSONAL DATA

We find that the planned processing of personal data will be in accordance with the principles under the General Data Protection Regulation regarding:

- lawfulness, fairness and transparency (art. 5.1 a), in that data subjects will receive sufficient information about the processing and will give their consent
- purpose limitation (art. 5.1 b), in that personal data will be collected for specified, explicit and legitimate purposes, and will not be processed for new, incompatible purposes
- data minimisation (art. 5.1 c), in that only personal data which are adequate, relevant and necessary for the purpose of the project will be processed
- storage limitation (art. 5.1 e), in that personal data will not be stored for longer than is necessary to fulfil the project's purpose

THE RIGHTS OF DATA SUBJECTS

We find that the information provided to data subjects about the processing of their personal data will meet legal requirements for form and content, cf. art. 12.1 and art. 13.

So long as data subjects can be identified in the collected data they will have the following rights: access (art. 15), rectification (art. 16), erasure (art. 17), restriction of processing (art. 18) and data portability (art. 20).

We remind you that if a data subject contacts you about their rights, the data controller has a duty to reply within a month.

FOLLOW YOUR INSTITUTION'S GUIDELINES

Our assessment presupposes that the project will meet the requirements of accuracy (art. 5.1 d), integrity and confidentiality (art. 5.1 f) and security (art. 32) when processing personal data.

When using a data processor (questionnaire provider, cloud storage, video call etc.), the processing must meet the requirements for the use of a data processor, cf. art. 28 and art. 29. Use suppliers with whom your institution has an agreement.

To ensure that these requirements are met you must follow your institution's internal guidelines and/or consult with your institution (i.e. the institution responsible for the project).

NOTIFY CHANGES

If you intend to make changes to the processing of personal data in this project it may be necessary to notify us. This is done by updating the information registered in the Notification Form. On our website we explain which changes must be notified. Wait until you receive an answer from us before you carry out the changes.

FOLLOW-UP OF THE PROJECT

We will follow up the progress of the project underway (every other year) and at the planned end date in order to determine whether the processing of personal data has been concluded/is being caried out in accordance with what is documented.

Good luck with the project!

Contact person: Sturla Herfindal 2/2

Vil du delta i forskningsprosjektet

«Koherens og tverrfaglighet i lærerutdanningen»

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å hente inn informasjon om koherens og tverrfaglighet i lærerutdanningen. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål
Vi prøver å finne ut hvor koherent studieforløpet er, både med tanke på selveste undervisning som foregår på campus og mellom undervisningen og praksis. Vi prøver også å finne ut mer om koblinger mellom fagene og tverrfaglig undervisning både på universitet og i praksisskolene. Målet vårt er å samle inn informasjon med tanke på fremtidige forbedringer i lærerutdanningsprogram. Målet er å samle informasjon fra forskjellige involverte partier i lærerutdanningen; studenter, praksis koordinatorer og veiledere, emne ansvarlige og program ansvarlig for å skape et helhetlig bilde.

Informasjonen skal bli brukt i både et forskningsprosjekt og en masteroppgave.

Hvem er ansvarlig for forskningsprosjektet?
Universitet i Agder er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Vi har valgt deg enten fordi du deltar i et relevant studieprogram og har vært ute i praksis, eller du har en ansvarsrolle innenfor læreutdanningsprogrammet. Vi vil gjerne snakke med deltakere som har vært i studieprogrammet mer enn ett år. Det er frivillig å delta.

Hva innebærer det for deg å delta?
Hvis du er deltaker fra grunnskolelærer utdanningen får du et spørreskjema som tar ca. ti minutter å fylle ut. Spørreskjemaet innebærer spørsmål om koherens i studieprogrammet

Andre deltakere ønsker vi gjerne å intervjue. Intervjuene vil ta ca. en time og innebærer spørsmål om studieprogrammet med tanke på koherens i
Undervisningsprogrammet som en helhet.
I og mellom emner.
Undervisning og praksis
Mellom undervisning og læreplanen.

Intervjuene vil bli tatt opp. Intervjuet vil bli transkribert rett etter intervjuet. Deretter slettes lydopptaket.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Deltakelse vil ha ingenting å si for karakterfordeling eller ditt forhold med fakultetet.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Det er kun den som gjennomfører intervjuet (masterstudenten eller en prosjektassistent fra Universitet i Agder) og prosjektleder, som vil ha tilgang til lydfilene fram til intervjuet er transkribert. Deretter slettes lydfilene. All data blir lagret på en sikker måte på UiA sine server. Navnet ditt og kontaktopplysningene dine vil ikke kunne kobles til dine svar. Data som blir brukt i publikasjoner vil være anonymisert og skal ikke kunne tilknyttes deg.

Hva skjer med personopplysningene dine når forskningsprosjektet avsluttes?
Prosjektet vil etter planen avsluttes i juni 2024. De anonymiserte data vil være tilgjengelig for videre forskning.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra Universitet i Agder Institutt for Pedagogikk har Personverntjenester vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:
innsyn i hvilke opplysninger vi behandler om deg, og å få utlevert en kopi av opplysningene
å få rettet opplysninger om deg som er feil eller misvisende
å få slettet personopplysninger om deg
å sende klage til Datatilsynet om behandlingen av dine personopplysninger

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:
Universitet i Agder ved Esther Canrinus på e-post esther.canrinus@uia.no eller Candice Reinhard Hansen, candicemr@uia.no
Vårt personvernombud: Trond Hauso på epost personvernombud@uia.no

Hvis du har spørsmål knyttet til Personverntjenester sin vurdering av prosjektet, kan du ta kontakt med:
Personverntjenester på epost (personverntjenester@sikt.no) eller på telefon: 53 21 15 00.

Med vennlig hilsen

Esther Canrinus	Candice Reinhard Hansen
Forsker/veileder	Master Student

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *«Koherens og tverrfaglighet i lærerutdanning»*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

å delta i spørreskjema utfylling
å delta i personlig intervju

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

---
(Signert av prosjektdeltaker, dato)

Appendix B: Survey Master Copy

Hei,

Med denne spørreundersøkelsen ønsker vi å evaluere hvordan dere opplever koherens og tverrfaglighet innenfor lærerutdanningen.
Alle dine svar vil være anonyme, og kan derfor ikke spores tilbake til deg. Når vi formidler våre resultater, vil det heller ikke være mulig å gjenkjenne deg ut fra hva du har besvart.

Det er frivillig å delta i denne evalueringen, og du kan trekke deg når som helst uten begrunnelse. Dersom du velger å delta, er det viktig at du besvarer alle spørsmålene så ærlig og fullstendig som mulig. Det finnes ingen «riktige» eller «gale» svar. Din stemme er viktig for oss og vi ønsker gjerne å vite hvordan du har opplevd lærerutdanningen slik at den kan forbedres.

Takk på forhånd for dine svar!

Mvh,

Esther Canrinus
Candice Reinhard Hansen

Hva er ditt kjønn?
(1) ❍ Kvinne
(2) ❍ Mann
(4) ❍ Andre

Hvilket år av GLU studiet du i nå?
(1) ❍ 1
(2) ❍ 2
(3) ❍ 3
(4) ❍ 4
(5) ❍ 5

Hvilke fag har du planer om å ta fordypning i?
(1) ❑ Norsk
(2) ❑ Engelsk
(3) ❑ Matematikk
(4) ❑ Kroppsøving
(5) ❑ KRLE
(6) ❑ Samfunnsfag
(7) ❑ Mat og helse
(8) ❑ Kunst og håndverk

Hvis du tenker tilbake på tvers av kurs/ seminarer du har fulgt innenfor lærerutdanningsprogrammet så langt; i hvor stor grad har du fått muligheten til å gjøre det

følgende?

Lære om visjonen for god undervisning som lærerutdanningsprogrammet promoterer
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Knytte sammen og overføre ideer fra en time til en annen time innenfor det samme kurset
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Knytte sammen og overføre ideer fra et emne til et annet emne
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Følge din egen læringsutvikling — reflektere over hvordan din egen forståelse av undervisning og læring har utviklet seg over tid
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Trekke forbindelser mellom undervisnings-/læringsteori og din egen undervisning i praksisklassen
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Hvis du tenker tilbake på lærerutdanningsprogrammet som du har fulgt så langt; hvor enig eller uenig er du i de følgende utsagnene?

Lærerutdanningsprogrammet har en klart uttalt visjon om undervisning og læring
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Jeg møtte de samme ideer om undervisning og læring på tvers av emnene i lærerutdanningsprogrammet

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

De som underviste, hadde god kjennskap til hva som foregikk på mine øvrige kurs (for eks. krav til oppgaver, pensumlitteratur og tilsvarende)

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Intensjonene med emne- og seminartilbudet på lærerutdanningsprogrammet er å videreutvikle min forståelse over tid

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Hvis de samme ideene eller den samme litteraturen ble gjennomgått flere ganger, ble de videreutviklet/drøftet mer inngående

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Jeg opplevde en klar sammenheng mellom ideer og begreper på tvers av ulike emner og seminarer

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Ofte møtte jeg motstridende visjoner og teorier om undervisning ved praksisskolen min i forhold til det som jeg lærte i emnene på lærerutdanningsprogrammet

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

I praksisperioden fikk jeg mulighet til å prøve ut de teoriene, strategiene og metodene jeg lærte i emnene på lærerutdanningsprogrammet

(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig

(4) ❍ Svært Enig

Det jeg lærte om i mine universitetskurs, reflekterte det jeg observerte i praksisperioden min
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

De som underviste i emnene ved lærerutdanningen, hadde godt kjennskap til programmet som helhet
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

På praksisskolen min observerte jeg at lærerne tok i bruk de samme teoriene, strategiene og metodene som jeg lærte om i universitetsemnene mine
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

De som underviste ved lærerutdanningen, refererte eksplisitt til innhold og begreper i andre delemner enn deres eget
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

De som underviste ved lærerutdanningen, hadde god kjennskap til mine arbeidsoppgaver på praksisskolen
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

De som underviste ved lærerutdanningen, kjente godt til typen og kvaliteten av mine praksiserfaringer
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

De neste spørsmålene handler om den nye læreplanen og tverrfaglighet
Hvis du tenker tilbake på lærerutdanningsprogrammet så langt; i hvor stor grad har du fått muligheten til å gjøre det følgende?

Bli kjent med den nye læreplanen LK20?
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Bli kjent med de nye elementene i LK20, f.eks. tverrfaglig undervisning og dybdelæring?
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Bli presentert med relevant teori tilknyttet til tverrfaglig undervisning og læring?
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Bli kjent med de tre tverrfaglige temaer, bærekraftig utvikling, demokrati og medborgerskap; helse og livsmestring
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Bli kjent med kompetansemål på tvers av læreplanen 5.-10.trinn
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Bli kjent med kompetansemål på tvers av læreplanen 1.-7. trinn
(1) ❍ Ingen mulighet
(2) ❍ Berørt det kort
(3) ❍ I noen grad
(4) ❍ Stor mulighet

Hvor stor mulighet har du fått til

	No opportunity	Brief opportunity	Some opportunity	Big opportunity
Observere tverrfaglig undervisning på universitet	(1) ❍	(2) ❍	(3) ❍	(4) ❍

Observere tverrfaglig undervisning på praksisskolen	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Planlegge tverrfaglig undervisning på universitet	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Planlegge tverrfaglig undervisning på praxis	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Undervise på en tverrfaglig måte på universitet	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Undervise på en tverrfaglig måte på praxis	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Diskutere eller reflektere om tverrfaglig undervisning på universitet	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Diskutere eller reflektere om tverrfaglig undervisning på praksis	(1) ❍	(2) ❍	(3) ❍	(4) ❍

Hvor trygg hadde du vært i å

	Veldig utrygg	Utrygg	Trygg	Veldig trygg
Undervise i mine fordypningsfag fra 5.-10.trinn	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Undervise i alle fag fra 5.-10.trinn	(1) ❍	(2) ❍	(3) ❍	(4) ❍
Knytte alle tre tverrfaglige temaer til mine fordypningsfag	(1) ❍	(2) ❍	(3) ❍	(4) ❍

Knytte alle tre tverrfaglige temaer til alle fag	(1) ❍	(2) ❍	(3) ❍	(4) ❍

Hva er mest relevant til din fremtidige karriere?

	Veldig urelevant	Urelevant	Relevant	Veldig relevant
Pedagogiske fag	(2) ❍	(3) ❍	(4) ❍	(5) ❍
Fagdidaktiske fag	(2) ❍	(3) ❍	(4) ❍	(5) ❍
Praksisperioder på skolen	(2) ❍	(3) ❍	(4) ❍	(5) ❍

Hvis du tenker tilbake på lærerutdanningsprogrammet som du har fulgt så langt; hvor enig eller uenig er du i de følgende utsagnene?

Jeg opplever at lærere på universitet fremmer tverrfaglig undervisning og læring
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Jeg har lyst å undervise kun i mine fordypningsfag
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Jeg ville føle meg komfortabel med å undervise på tvers av fag
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Dybdelæring er mulig uten tverrfaglighet
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Jeg synes grenser mellom fag er viktig å ha
(1) ❍ Svært uenig

(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Jeg har tverrfaglighet som et mål i undervisning min
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Tverrfaglighet er en viktig del av dannelsesprosessen
(1) ❍ Svært uenig
(2) ❍ Uenig
(3) ❍ Enig
(4) ❍ Svært Enig

Hvis dere har noe å tilføre, skriv det gjerne her
_____
_____
_____
_____
_____
_____

Tusen takk for at dere har svart på spørsmålene!
Hvis dere har noen spørsmål angående spørreskjemaet, tar gjerne kontakt med Esther Canrinus (esther.canrinus@uia.no) eller Candice Reinhard Hansen (candicemr@uia.no). Vi vil veldig gjerne høre mer fra dere! Om du kunne tenke deg å stille til intervju så hadde vi vært svært takknemlige. Det ville ta ca. en halvtime - time av tiden din, og vi spanderer drikke og snacks! Ta kontakt med Kristin, Esther eller Candice.

Appendix C. Interview Guide

Interview Guide Questions

Coherence and Interdisciplinarity

1. Which program are you currently studying?
2. Which year?
3. Which subject/s have you chosen to specialize in?
4. What do you believe "program coherence" entails?
5. Considering your study program, to what extent would you consider it to be coherent?
6. To what extent do you do you think it is important that a program is coherent, and can you explain why or why not?
7. What do you think could be done to improve coherence in your course?
   a) between university and practice
   b) between subjects within a year
   c) between subjects in different years of the study program* (Not for PPU)*
8. To what extent do you perceive your program as practically relevant to your future profession?
9. To what extent do you perceive your current subjects as relevant and coherent to your future profession?
10. What are some examples where your study program has linked directly to practice?
11. To what extent do you feel you have sufficient opportunity to discuss your experiences in praxis with peers and teachers and jointly reflect upon them? (Prompt with at school in a formal context, at school in an informal context, in praxis or off campus)
12. To what extent do your pedagogy teachers mention explicit connections to other subject content within your study program?
13. In your subject-specialization (fagdidaktikk) subject/s, to what extent does your lecturer make content-based connections to other subjects. E.g., connecting religion (i.e., Islam) to mathematics (i.e., geometry)?
14. What do you think about learning about other subject specializations? (for example, is it useful or not necessary?)
15. In LK20 there is a lot of focus on two new elements, deep learning and interdisciplinarity. To what extent have these been presented or discussed in your program?
16. Is the term "interdisciplinary" used in your study program?

17. What does interdisciplinarity mean to you?
18. To what degree have you had instruction on how to plan and teach in an interdisciplinary way?
19. Have you observed interdisciplinarity during your praxis – in which context? (e.g., teaching or teacher discussion, professional development etc).
20. To what extent do you think interdisciplinarity is possible within your professional context?
21. To what extent do you think interdisciplinary approaches could be used within your subject-specialisations?
22. To what extent do you believe deep learning is possible without interdisciplinarity?
23. In LK20 there are three interdisciplinary themes: Sustainable Development, Health and Life Skills and Democracy and Citizenship. These are intended to span the entire school progression. To what extent are each of these themes mentioned in your study program?
24. To what extent do you think that one or two subjects should take primary responsibility for covering these themes?

Appendix D: Descriptive Statistics & Open-Ended Responses

D1. Descriptive Statistics Beliefs Variables

Variable	*Number*	*Median*	*IQR*
Interdisciplinarity helps develop pupils' Bildung.	130	3.00	0
I have interdisciplinarity as a goal in my teaching.	130	3.00	0
I would feel comfortable teaching across subjects.	130	3.00	0
I believe subject boundaries are important to have.	130	3.00	1
I only want to teach within my subject specialties.	129	3.00	1
Deep learning is possible without interdisciplinarity.	130	2.00	1

D2. Descriptive Statistics University Variables

Variable ***"How often did you get the opportunity to..."***	***N***	***Mdn***	***IQR***
Observe ID teaching	127	2.0	1
Plan ID teaching	127	2.0	1
Teach an ID session	127	2.0	1
Discuss/Reflect on ID teaching	127	2.0	1

D3. Descriptive Statistics: Curriculum

Variable… "opportunity to become familiar with"	***Number***	***Median***	***IQR***
Overall Curriculum	130	3.25	2.25
The new curriculum LK20	130	4.0	1
The new elements: deep learning and interdisciplinarity	130	3.0	1
The three interdisciplinary themes	130	3.0	1
Competency goals 1 - 7	130	3.0	2
Competency goals 5 - 10	130	3.0	2

D4. Coherence Variables Descriptive Statistics

Variable	*N*	*M*	*Mdn*	*IQR*
I am met with the same ideas regarding teaching and learning across subjects.	130	2.77	3.0	1
I experienced a clear connection between ideas and concepts across subjects.	130	2.65	3.0	1
I have the opportunity to connect and transfer ideas from one subject to another subject.	130	2.55	3.0	1
The teachers who teach in teacher education explicitly referred to content and terms in other subjects.	129	2.30	2.0	1
Overall	***130***	***2.57***	***2.5***	***1***

D5. Descriptive Statistics Praxis Scale

Variable ***"How often did you get the opportunity to..."***	***Number***	***Median***	***IQR***
Observe ID teaching	128	3.0	1
Plan ID teaching	128	3.0	2
Teach an ID session	128	3.0	2
Discuss/Reflect on ID teaching	128	3.0	2
Overall	**128**	**3.0**	**1.31**

D6. Descriptive Statistics Confidence Scale

Variables "How confident would you be"	**Number**	**Median**	**IQR**
Overall Confidence	130	2.90	0.40
Teaching your subject specializations grades 5 – 10?	129	3.00	1.00
Teaching all subjects from grades 5 – 10?	129	3.00	1.00
Connecting the three interdisciplinary themes to your subject specializations?	129	3.00	1.00
Connecting the three interdisciplinary themes to all subjects?	129	2.00	1.00

D7. Responses to Open-Ended Variable (5GLU)

"The pedagogical subjects are very important, but the way they are conducted at university has been very disappointing. The teachers put the responsibility on us and take responsibility only for a small portion of what is necessary to learn, which is often very distant from our future professional practice. Overall, this is a subject with a lot of potential, but the prioritization of literature (pensum) has been disappointing."

"I think everything we learn in pedagogy is pretty irrelevant to my working life".

"Those who teach in GLU should follow a grade through the whole course progression to know what the students have been through earlier. A lot of repetition of theories covered from years 1 - 5, but not a lot of going in depth".

“We hear a lot about how interdisciplinarity is important, however, there are few examples presented in how to actually work with it”.

“I wish we could get more teaching about how to work in an interdisciplinary way within our subject specializations”.

"I experience that the teachers focus on the subject specializations as opposed to everything else we have to deal with as teachers. I miss more information on how to deal with parent and pupil conversations and meetings. In the subjects I experience that we learn a lot of theory, but not much on how we actually teach."

"Pedagogy is set up horribly in my opinion, way to elongated and abstract. Theory is important, but when it is explained so poorly through five years, we are just fed up. I think this is why many of us find praxis periods so much more useful than the theoretical teaching at university".
