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Doing knowledge work differently: problem-based projects as encounters in coming-to-know

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Abstract

International education scholars often theorise alternative models of knowledge work in the university. These imagine the transformation of teaching and learning and a more inclusive society. This article presents the case of a university in Denmark, where problem-oriented, interdisciplinary, collaborative project work has been the pedagogic norm for over forty years. It draws on a theoretical basis that asserts the value of a different onto-epistemological paradigm for *doing* knowledge work, one that engages students in knowing as *troublesome* (stimulated through a personally-interesting complex issue) and *contested* (subject to different perspectives and purposes) to enact *immersive* and *multifaceted* learning processes. Mixed-method data from the case illustrate plural outcomes of the approach. While quantitative achievement data reveal a general pattern of higher achievement in problem-focused projects when compared to coursework, teasing into qualitative statements reveals a matrix of co-existing outcomes and epistemic dispositions for graduates. While a singular case, the study illuminates the ways that learning outcomes entwine with the ways students encounter and generate knowledge in a university setting. Through processes of inquiry, students are invited to develop epistemic dispositions for engaging willingly with complexity, knowledge, others, and the world.

Keywords University pedagogy · Problem-based learning · Inquiry learning · Case study · Educational effects · Danish Project Studies

Knowledge work in the university

'The project work was an important cue to seek more knowledge. [It gave me the] freedom to be professionally curious'
(R#173, Master; 1986)[1]

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[1] Key: Survey Respondent Number, Degree Program/s Completed, Year Graduated.

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An inquisitive disposition is a characteristic of critical thinkers and an increasingly important graduate attribute (Facione, 2006, cited in Flores et al., 2012). Barnett (2009) argues that the development of valued dispositions in university graduates — such as a willingness to be curious in the pursuit of knowledge – is entwined with approaches to curriculum that are demanding, offer contrasting perspectives, and require both individual commitment and collective accountability. While the key task of universities is to facilitate educational experiences that engage students in and with advanced forms of knowledge, traditional education paradigms can struggle to offer students opportunities to let their own curiosity drive encounters with new information (Connell, 2019). This awareness of the limitations of traditional curriculum and pedagogy informs international scholars' continued calls for higher educational models that are:

- collaborative, complex, and critical (Barnett, 2009; Connell, 2019; Stoller, 2014; Wenger, 2011; Tassone et al., 2018);
- embrace uncertainty (the 'mess' of knowledge generation; see, Connell, 2019; Savin-Baden, 2020; Wenger, 2011); and
- are committed to democratic action and inclusivity (Barnett, 2013; Biesta, 2010; Connell, 2019; Stoller, 2014).

These ideal principles reflect an educational paradigm that engages students simultaneously in *processes* of coming-to-know as well as the *products* of prior inquiries. The aim is to transform students — and therefore society — through the development of *knowing* (not just knowledge) and *knowledge-based* dispositions and qualities. Barnett (2009) calls these desirable dispositions 'epistemic virtues', positing that a willingness to engage or a preparedness to listen to others are ways of engaging with the world that embody 'modes of human being that may be particularly appropriate for an age of supercomplexity' (p. 440).

This paper offers an empirical case-based exploration of inquiry learning as an exemplar of an educational model that enacts these principles. The signature pedagogy at the case university – a Reform university located in Denmark — takes a problem-oriented, interdisciplinary, and collaborative approach to project work. Here, I explore this kind of knowledge work through processes where *troublesome* and *contested* knowings support *immersive* and *multifaceted* engagements with knowledge. These processes entwine with demonstrated outcomes, including higher achievement, and *complex* and *critical* understandings. Simultaneously, these encounters invite the development of particular epistemic dispositions. While a singular case, situated within a unique historical and cultural context, the study gives insight into broader higher education concerns about how pedagogic approaches that deliberately promote student development beyond technical qualification might be realised at the institutional level (see, Biesta, 2010). Further, as per Barnett's (2009) assertions, it serves to reassert the role of knowledge as ineradicable within higher education, and to consider the ways that particular kinds of encounters with knowledge and changes in human being are intimately related.

Coming-to-know, coming-to-be: theorising inquiry learning

Higher education aims to enable student development through encounters with knowledge (Barnett, 2009; Connell, 2019). The ways universities structure these encounters invite certain possibilities for knowing and for the development of knowledge-based dispositions and qualities (Barnett, 2009). This position views knowledge work in universities, those

encounters where students engage in *doing* learning (Boys, 2011), as interconnected with the development of knowledge, knowing, and certain ways of engaging with and being in the world. Here, the assumption is that the 'very process of coming to know has educational properties' (Barnett, 2009, p. 437), where particular encounters engender particular kinds of changes in human beings. This view is central to inquiry approaches in education, which view the processes of knowledge creation as pivotal to students' holistic development (Stoller, 2014).

Essentially, this view sees the outcomes of education as inseparable from the processes through which students achieve them. The philosophy of learning through inquiry understands that the acts of inquiring 'not only yield the creation of emergent meanings and knowings… but they also transform the existing situation—*including the person and world*—as part of the process' (Stoller, 2014, p. 101, drawing on Dewey, 1938/1984). This view differs from traditional education and:

> shifts the center of gravity in education from being organized around objective facts to which learners serve as containers and, instead, elevates the unique and continual reconstruction that the self undergoes as part of the process of education the guiding force of education. Here, education is an act of doing or making, which is ultimately transformational of both self and the world (Stoller, 2014, p. 11)

Active, collaborative inquiry into personally significant issues is a demanding form of knowledge construction through experimentation. This process offers certain opportunities to students to concurrently develop knowledge and 'more open and radical' ways of engaging with the world (Feldt & Petersen, 2021, p. 66; Schraube & Marvakis, 2019). The onto-epistemological position assumes knowing (and coming-to-know) and being (and becoming) as inherently inseparable (Barnett, 2009). With this understanding, the practices of inquiry (processes for engaging with knowledge) and the outcomes of engagements with knowledge (including knowings and knowledge-based dispositions) are integrated — the investigation problems, curriculum content, learning practices, and learning effects emerge, exist, and are considered together.

A context for Reform: coming-to-know differently

Before moving to Denmark, I was unaware of the European Reform universities or their history. As an Australian higher education researcher, the thought of entire institutions founded on and dedicated to the sustained practice of student-led, inquiry-focused, collaborative approaches to curriculum was incomprehensible (and sufficiently intriguing to motivate an intercontinental shift in location). It appears I was not alone in my limited awareness. While international scholars of education continue to rethink and reimagine educational practice, theorising more transformative, inclusive, and democratic educational processes and outcomes (see, for example, Barnett, 2013; Biesta, 2010; Osberg & Biesta, 2008; Stoller, 2014), few explicitly consider that these kinds of pedagogies may already exist in sustained, systematic incarnations. This is perhaps unsurprising. Problem-led approaches to learning are not often instituted or evaluated as an integrated, whole-of-institution curriculum philosophy (Acton, 2019; Savin-Baden, 2003). Connell (2019), in considering *The Good University*, is seemingly alone in advocating Europe's Reform universities as offering a wealth of experience to universities globally who wish to implement

equitable, inclusive, and democratic pedagogies. In light of this, I outline a brief history of the Reform universities, focusing on the approach to learning as practised in Denmark.

Reform universities have a long history in Europe, established in the 1970s in response to a suite of political, student-driven, and industry-related concerns. These viewed traditional education as insufficient to prepare graduates for a changing labour market that increasingly required applied interdisciplinary knowledge and generic competences. There was a sense that universities reflected a paradigm of education that was elitist, individualistic, abstract, and constrained by arbitrary disciplinary boundaries rather than being led by complex problems (Andersen & Kjeldsen, 2015; Kolmos, 2009; Warren, 2019). In this context, a series of universities, including Bremen University in Germany, Maastricht University in the Netherlands, and Aalborg and Roskilde Universities in Denmark, were established. These were founded on a deliberately alternative problem-based project model of learning, carried out through collaborative inquiry into personally-interesting and societally-relevant interdisciplinary issues (what might now be called 'wicked problems'). The approach simultaneously emphasises students' knowledge construction and competence development, especially those generic capabilities related to teamwork, communication, information literacy, critical thinking, and solution-oriented ways of working.

Although pioneering at the time, problem-based and inquiry learning methods often continue to be seen as 'innovative' and 'experimental', and — despite evidence of their educational value — remain contested in higher education contexts (Savin-Baden, 2020). The skepticism that can surround the approach was seen in Denmark recently, with one of the Reform universities required to respond to public criticism about its pedagogic approach and student outcomes (see, Eriksen, 2020). Despite this, the debates of the 1970s that graduates require knowledge coupled with generic skills and civic awareness remain pertinent in the sphere. Thus, the uniqueness of the institutional scale and the longevity of the pedagogic implementation in Reform universities, aligned with the 'ideal' educational principles outlined earlier, makes for an insightful research case (Rienekker & Jørgensen, 2018). As universities globally seek to innovate higher education to better educate, engage, retain, and support students who are capable of responding to changing labour markets and complex societal problems, Reform universities' sustained practice in implementing institution-wide collaborative inquiry offers a salient opportunity to ascertain the outcomes of a student-centred, active, and collaborative pedagogy.

A Danish case

In the Danish Reform universities, while some changes have been made over the last 40 years (projects are now six rather twelve months), participatory group inquiry remains integral to knowledge work. Aalborg and Roskilde Universities exemplify this process in what is referred to as Danish Project Studies (DPS) (Christensen, 2016). DPS enacts problem-focused, interdisciplinary, collaborative, participant-directed project work, which makes up half of students' study workload from their first semester (Andersen & Heilesen, 2015; Christensen, 2016). The process begins when a small group of students (between two and seven participants), working with a supervisor, articulate a 'problem' (a complex issue) to investigate over the semester. This distinction is crucial: *students* — rather than teachers — determine the inquiry area and problem formulation that guides learning. This overcomes concerns regarding the common separation of the 'what' (content) and the 'how' (method) of learning. While much education takes decisions about what is studied out of students' hands; in DPS, 'learners themselves have to decide that the learning

problem makes sense for them, and see they actually have something to learn through the learning act' (Schraube & Marvakis, 2019, p. 444).

This problem then becomes the focal point that stimulates a highly autonomous version of problem-based learning (PBL), where collective work processes support knowledge development (Christensen, 2016). With an emergent curriculum, groups decide relevant reading topics, theoretical perspectives, and methods of inquiry, consolidating learning and justifying their decisions in a project report. Projects are iterative, with a new topic and project group each semester. This counters Connell's (2019) criticism that universities often enact knowledge-transfer focused, 'textbookized' forms of curriculum, where students are limited to 'a pre-determined body of information, techniques and rules' (p. 45). Concurrently, the other 50% of students' study load consists of engagement in course work designed to complement and enhance project work. Although intended to align, courses take a more traditional, individual, teacher-led approach to learning.

Assessment in DPS occurs at several junctures. Students submit a unified project report at the end of each semester, also participating in an oral exam, which together summatively assess knowledge, skills, and competences developed by requiring students to explain and defend their approach and conclusions (Warren, 2019). Projects are judged based on criteria in the study regulations and national standards (as are coursework subjects). At key stages in the degree cycle (semesters three and six in a Bachelor degree) censors external to the university assess student work and award grades. This allows for moderation and quality assurance. While groups work and present collectively, grades are able to be awarded individually when students demonstrate differing levels of understanding. Formal formative evaluation activities scaffold students' inquiries, with written summaries and oral presentations of in-progress work reviewed by two university staff members at two junctures during the semester. In contrast, course work is generally assessed in traditional ways (written exams or essays) by the course lecturer. This awareness of two educational paradigms operating simultaneously sparked my wondering if there were differences in student achievement in the two domains (as there were in other comparative studies).

Through the case of one of the Danish Reform universities, this paper explores the ways of doing substantive knowledge work in a university where Danish Project Studies (DPS) is the pedagogic norm and some of the effects of that education. It is guided by the overarching question:

> What are the graduate outcomes of Danish Project Studies at a university where it is practised as an institutional signature pedagogy?

> A series of contributing questions aided the inquiry and analysis:

1. Are there notable differences in student achievement, when comparing DPS and coursework?
2. How do graduates describe their learning outcomes, when comparing DPS and coursework?
3. In what ways do graduates' descriptions articulate a relationship between pedagogic process and learning outcomes?

Findings from the case suggest that educational processes and graduate outcomes are interrelated, with knowing, doing, and being inseparable.

Methodology

Seeking to inquire into the effects of Danish Project Studies, the study worked with an interpretive paradigm. Interpretive research aims to 'gain understanding by interpreting subject perceptions' (Lincoln et al, 2011, p. 102). It is underpinned by a transactional epistemology, which assumes that the creation of knowledge happens in and through localised personal interactions with others (Guba & Lincoln, 1994 in Lincoln et al, 2011). In addition, a relativist ontology that views 'truth' as plural and co-constructed allows multiple realities to be represented (Guba, 1996 in Lincoln et al, 2011). This works in synergy with a theoretical orientation that views the *ends* (outcomes) and *means* (processes) of *doing* learning (coming-to-know) as irrevocably entwined (Barnett, 2009; Feldt & Petersen, 2021; Stoller, 2014). A case study strategy is a suitable way of investigating and representing these connections.

Case-based research aims to highlight the interrelations between context and social practice (Stake, 2003; Yin, 2003). The paper assembles data relating to educational outcomes across two stakeholder groups, students and graduates, from one DPS university, aligned with the research questions (see Table 1). This approach responds to a gap in the literature that identified a dearth of graduate perceptions in the evaluation of problem-oriented approaches (see Acton, 2019). In this article, I work with quantitative longitudinal achievement data from one student cohort (n. 729) and mixed method survey data from graduates (n. 223). Achievement data were mapped according to the percentage of students awarded different grade levels in both DPS and course work over the course of a Bachelor degree program. The survey design was informed by an initial small-scale pilot, which provided a foundation on which to decide significant topics for inclusion and to trial wording and vocabulary (in Danish and English), critical factors in mixed-method survey design (Hitchcocka et al, 2015). Questions included open-ended qualitative responses, such as What do you feel were the strengths of project group work? What do you feel you learnt as a result of this? Other aspects asked for a selection of responses that were calculated quantitatively (see Table 2 for example). Although there are limitations to self-report methods, their strength is that they allow personal perceptions about significant educational outcomes to be shared (Jin & Bridges, 2016).

A thematic analysis of qualitative survey comments facilitated an inquiry into both the effects of DPS narrated by graduates and how and why achievement is different in DPS. This enacted a content-driven, exploratory approach (Guest et al, 2012), which identified repetitive themes (such as 'knowledge'), categorised and coded data in themes and sub-themes (e.g., 'specialised knowledge', 'nuanced knowledge'), and clustered these for subsequent appraisal, working with theory (in this case, regarding collaborative inquiry processes) and findings from literature to make sense of the educational implications (Ryan & Bernard, 2003). This methodological assemblage allowed for sensing into complex and rich educational outcomes, allowing multiple — and contradictory — viewpoints to exist together (see, Petersen, 2016, 2020).

While a singular case may not be generalisable, research knowledge may be transferable and of value to the field (Flyvbjerg, 2011). In this instance, the case works to assert and demonstrate the role of knowledge in student development by illustrating the ways that increased achievement and changed dispositions in DPS is entwined with those processes through which students assemble their understandings.

Table 1 The study's research design

Research questions	Method	Data source	Participants	Analysis
1. Are there notable differences in student achievement, when comparing DPS and coursework?	Map patterns of achievement over a degree	Achievement data	Students	Descriptive statistics
2. How do graduates describe their learning outcomes, when comparing DPS and coursework?	Mixed method survey	Quantitative and qualitative survey responses	Graduates	Descriptive statistics Thematic analysis
3. How do graduates' descriptions articulate the relationship between practice and outcomes?	Mixed method survey	Qualitative survey responses	Graduates	Thematic analysis

Table 2 Graduate responses indicating preferences and learning in DPS and course work

Comparing DPS and course learning (Please select all that are relevant)	Responses (n. 223)	As percent
I preferred DPS group work	62	27.8%
I preferred independent course work	20	9%
I appreciated a balance of DPS and course work	163	73%
I learnt more in DPS group work	87	39%
I learnt more in independent course work	15	6.7%

A different kind of knowledge-work: presentation of data

This section begins with a comparison of DPS and course work achievement patterns for one cohort of students. I then explore what underpins these differences in achievement, considering knowledge work practices and correlated effects of DPS together. Rather than implying causality, this illustrates the ways that the processes of *doing* learning and the *effects* of learning interweave in graduates' comments. This is understood to invite the development of certain dispositions for engaging with the world. In this way, knowing and being (differently) – as educational effects – are understood to exist *in* and *with* the acts of coming-to-know.

Achieving differently: tracking grade distribution

Longitudinal student achievement data of one university cohort highlights differences between student achievement in DPS and coursework. For those who graduated from the university with a Bachelor in 2019, the previous six semesters' results were aggregated to ascertain any notable patterns or differences in achievement between independent course work grades and those achieved through collaborative DPS (see Fig. 1). The figure maps in percentages the university-wide figures for the cohort (n. 729 in total[2]).

The data illustrate that while between 3 and 12% of students are unsuccessful in their attempts to achieve a Pass standard in course work, only 1–4% of students fail in DPS. Although 10–16% achieve the highest grade in independent course work, in DPS, this increases substantially, with 19–32% of students achieving this standard. This was not unexpected. Other studies converge in the finding that problem-oriented pedagogies result in higher academic achievement for students (Fujinuma & Wendling, 2015; Laursen et al, 2016; Luo, 2019; Valenzuela et al, 2018; Zhao, 2016). The pattern also exemplifies Vygotsky's (1978) social-constructivist theory that students are able to achieve more collaboratively through working with 'more capable others' who extend them beyond what they currently know and can do.

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[2] Student cohort completed degree requirements in spring 2019. Due to differences in progression, student numbers change each semester. Percentages allow comparison. Semester 1, autumn 2016: 727 students, grades awarded: 836 CW; 741DPS; Semester 2, spring 2017: 715 students, grades awarded: 1012 CW; 727 DPS; Semester 3, autumn 2017: 682 students, grades awarded: 1416 CW; 687 DPS; Semester 4, spring 2018: 729 students, grades awarded: 1518 CW; 748 DPS; Semester 5, autumn 2018: 672 students, grades awarded: 1567 CW; 688 DPS; Semester 6, spring 2019: 677 students, grades awarded: 658 CW; 693 DPS.
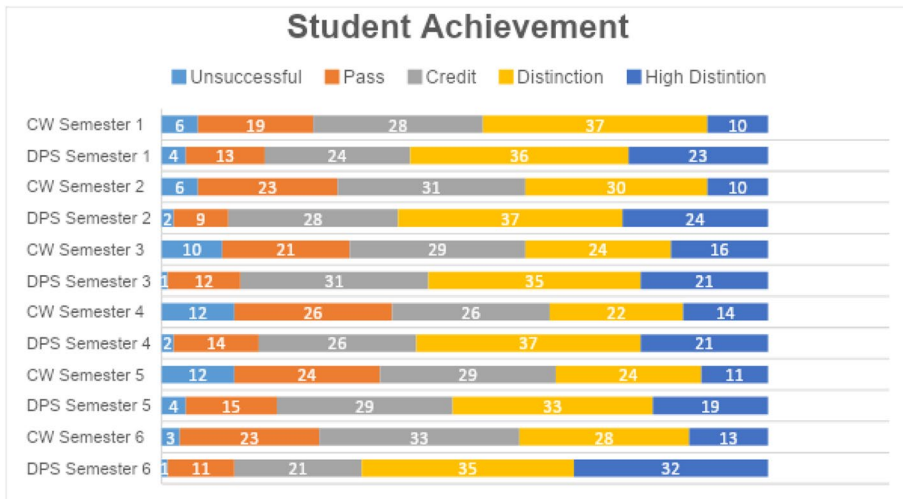
Fig. 1 Comparison of course work (CW) and Danish Project Studies (DPS) achievement by percentage, autumn 2016 to spring 2019

Still, a question remained as to whether higher achievement correlated with enhanced learning, especially given concerns about student 'free-riders' in groups (although shared goals and group interaction can act as a counter to this issue — see, Luo, 2019). Graduate survey data became a complement, indicating that 39% of respondents felt that they did learn more in DPS, compared to 6.7% who felt they learnt more in course work (see Table 2). Although students in general achieved more in DPS, and graduates reported more often that they preferred DPS (27.8% compared to the 9% who preferred course work), the vast majority valued the balance of DPS and course work at the university (73%).

This reiterates an earlier longitudinal comparative study that found that different pedagogic approaches are complementary, although self-directed learning methodologies, such as PBL, 'contribute most significantly to improving student learning' (Serdà & Alsina, 2018, p. 582; see also Klegeris et al, 2017). With data indicating differences in patterns of achievement, the survey data presented below explores this further.

DPS processes and outcomes: why and how achievement is different

Graduate survey responses give insight into why and how student achievement differed in DPS. Two ways of doing knowledge work practised at the case university indicate processes of doing learning at play in higher achievement. Rather than providing students with pre-decided information, student-involved inquiry engages students with *troublesome* and *contested* knowledge, enabling a kind of knowledge work that is described as *immersive* and *multifaceted*. These processes of coming-to-know in the DPS university relate to nuanced descriptions of knowledge-based outcomes (*complex* and *critical* knowings). These encounters are understood to inform and invite the development of certain epistemic dispositions (see Table 3).

While these themes from the data are grouped for analysis, I acknowledge that the boundaries between them are more blurred than they appear in the writing.

Table 3 The alignment between knowledge work processes and outcomes in DPS

Knowledge work process	Encounters with knowledge as…	Knowing outcomes	Invited epistemic dispositions
Immersive	*Troublesome*: coming-to-know arises from engagement with personally-relevant problematics that create shared interest for the group	Complex, varied understandings of knowledge and its construction	Willingness to engage in complex societal issues Preparedness to persevere with the 'problem' Readiness to know differently
Multifaceted	*Contested*: engagements with knowledge occur in collaboration and are multifaceted, conflicting, plural, and difficult to reconcile	Critical, nuanced view of knowledge and its construction	Courage to make claims based on knowledge-in-use (intellectual integrity) Openness to alternative views (intellectual humility) Willingness to explore differing understandings and solutions (curiosity)

Knowledge as troublesome: immersion and complex knowings

In DPS, as in PBL, a 'trigger' that unsettles or challenges existing understandings motivates knowledge development through problem-focused investigation (Savin-Baden, 2020). In this way, the awareness of one's own incomplete knowledge becomes the basis for personally relevant knowledge work. When learning occurs in response to a problematic situation, students' whole selves become absorbed in the process, making the act of knowing more than simple cognition (Stoller, 2014). It is this whole-self *immersion* in learning that invites students to engage to different ways of knowing the world, developing dispositions along with new knowing. Immersive work processes entwine with narratives of the *complex knowings* graduates developed in DPS experiences.

Immersive learning: Inquiry begins with an experience of knowledge as troublesome, with a sense of 'disequilibrium between the cognitive (thought), emotional (feeling) and habitual (action)' (Stoller, 2014, p. 66, drawing on Dewey, 1938). This then launches students — intellectually, affectively, bodily — into an inquiry of personal interest. Graduates repeatedly described the 'immersive' process of doing learning in DPS as a key strength of the pedagogy. Alumni describe an active state of doing learning, where they "learned to work in depth with theories and let concepts get under the skin that were put into play in practice" (R#143, Master; 2010). As one participant stated: "It gave the space required *to put me into the stuff*" "(R#98, Master; 2019). In this state of *absorption,* "only the subject matter is present in consciousness" (Dewey, 1897, p. 56).

This was not only individual. In DPS, immersive work was valued as a collective experience with invested peers:

> The [strength of DPS was the] opportunity to immerse yourself in an academic issue with a dedicated group of fellow students. Through this I came to know my academic and social strengths and limitations, and I learned to complete a task through co-creation and teamwork (R#20, Master; 2014).

Others echoed this appreciation. For Respondent #160,

> project work gave me the opportunity to immerse myself in professional knowledge over a longer period of time than I could achieve through shorter tasks/courses. In addition, the group work gave me a great advantage in acquiring this knowledge, as I was not limited only to my own skills and vision, but could draw benefits and synergies from my fellow students (Master; 2011).

Previous studies have similarly shown that in student inquiry, learning outcomes improve with sustained engagement with one complex problem compared to multiple short problem cycles (Ayala et al, 2019; Golightly, 2018; Laursen et al, 2016; Müller & Henning, 2017). Hull et al (2016) similarly found that working with material over an extended period resulted in powerful student learning experiences, which were enabled by preparation, analysis, reflection, and interpretation that then allowed students to collaboratively process and translate learning experiences into lessons for practice. This process of immersion, requiring students to engage collectively in content in sustained ways, entwines with achievement. It also invites a dispositional willingness to engage in complex societal problems and a preparedness to persevere in coming to know differently.

Complex knowings: Through the process of immersion graduates engaged with concepts and theories in DPS, enabling complex and co-existing knowledge outcomes. Graduates narrated that the knowledge gained was variously perceived as deep, deep and narrow, broad (in a positive sense), broad (in a negative sense), shallow or superficial, and both broad and deep. Graduates' descriptions regularly suggested a sense of deep knowing, reflecting a focused, comprehensive knowledge of a specific topic. Representative of the theme, Respondent #14 recounted that, "[DPS] gave me highly specialised knowledge of the topic we wrote about" (Master; 2003). For another DPS enabled "specialised knowledge in the theories and subject areas used" (R#161, Bachelor; Master; 2019).

While specialised knowledge was appreciated, this twisted with a sense of narrowness. Although DPS provides opportunity to study specific areas in depth, a narrow focus can be a limitation in a problem-oriented approach (Andersen & Heilsen, 2015). Respondent #20's comment reflected this, stating that DPS secured "highly focused in-depth knowledge of specific theories, methods and academic fields that in some cases have proven too narrow and in others very useful" (Master; 2014). Another felt that the knowledge developed was "sporadic. I learned a lot about some partly randomly selected academic areas that are not necessarily rewarding for me now" (R#107, Master; 2017). While the pedagogy aims to make explicit connections to broader societal issues and scientific fields, this may not be realised if the responsibility is left to students alone (Andersen & Kjeldsen, 2015). While unspoken in the comments, the underlying implication is that active supervision in needed to connect the content of students' inquiries beyond the scope of each project.

While some felt their knowledge was deep but narrow, this juxtaposed with others who described their understandings as broad and, at times, superficial. One explained that their knowledge was "not specific enough, but wide" (R#196, Master; 2018) while another felt, "critically speaking, I would say that my expertise is superficial" (R#221, Master; 2019). However, this distinction between deep and narrow *or* broad and superficial clashed with other statements where respondents felt that DPS supported both deep, specific *and* broad, general knowledge development:

> [DPS] provides depth in different subject areas. Each project is an opportunity to examine problems and themes without being superficial. The group as a unit, of course, allows you on one hand to immerse into the subject, or delve into several subjects at the same time. It is clear that a wide understanding of knowledge must follow, but in the project work the breadth and depth can work great together (R#206, Master; 2012).

Respondent #176 reiterated this; "[I gained] broad knowledge of the dominant theories in my field, together with the possibility of cultivating specific niches within one's field of interest" (Bachelor; 2019). Problem-based approaches have previously been found to support deep learning and intrinsic motivation through inspiring students' curiosity in personally relevant areas (Yardimci et al, 2017, see also Fujinuma & Wendling, 2015). The range of outcomes suggests that although achievement in DPS may be higher, the ways that graduates perceive this can vary significantly. There is an implication that the processes of DPS can scaffold a dispositional willingness to engage with complex issues in the pursuit of new understandings. These invitations though may to be taken up in different ways by different students.

Knowing as contested: multiple perspectives and critical knowings

Inquiry learning aims to expand student thinking through engagement with diverse under-standings, ideally with pre-existing positions suspended in encounters with alternative understandings (Stoller, 2014). In DPS, interaction with different perceptions is an integral process in coming-to-know. Collaborative work supports this through interaction with oth-ers as well as information, creating a space where differing perspectives and approaches come up against each other and must be weighed, debated, and decided. Although this ena-bles new, expanded understandings to emerge, "conflict is an inherent part of cooperation" (Johnson & Johnson, 2012, p. 114). Below, work processes in DPS are shown to involve encounters with *multiple perspectives* (both as strength and challenge). Tangled up with this is an outcome of *knowing critically*, where graduates perceived that DPS enabled the development of critical, nuanced understandings that valued different views. These related processes, outcomes, and invitations entwine with higher achievement and dispositional development in DPS.

Multiple perspectives: Cooperative group work requires students to negotiate and recon-cile different views to achieve joint learning goals. This is not often without tension (John-son & Johnson, 2012). Even so, graduates consistently described the mélange of differ-ing perspectives in DPS as of significant benefit to learning. Indeed, qualitative comments listed it as one of the primary advantages of the pedagogy. Indicative of other comments within the theme, alumni described the interplay of differing perspectives:

> [The strength of DPS was] being confronted with alternative readings and interpreta-tions of data and theory (R#59, Bachelor; Master; 2017)
> [I learnt] that differences can be turned into positive resources when the shared inter-est revolves around the topic (R#116, Bachelor; 1982)
> [It was a challenge] to recognise that different approaches have value – and that the end result becomes better with different approaches (R#203, Master; 2001)

Rather than simply being comfortable sites of discussion and social support, peer group negotiations were viewed as challenging sites of argumentation, contestation, and debate. These kinds of critical and constructive dialogical spaces, where students discuss and ques-tion multiple viewpoints, are crucial to robust knowledge development (Tassone et al., 2018; Wenger, 2011).

Even as it was recounted as a strength of DPS, the realities of negotiating multiple per-spectives were acknowledged as difficult. Respondent #113 reflected: "[The strength of the pedagogy was] I was challenged as a student AND as a human being, at the same time I learned to approach academic challenges from many perspectives" (Master; 2019). Simi-larly, Respondent #69 felt that a challenge was "Different world views – [I learnt] tolerance and inclusion" (Master; 1992). Another explained:

> Sometimes it is problematic to be many group members, with many different per-spectives on everything from collaboration to everyday life and the topic… I've mainly had good collaborations, but I've also tried to hand in some rubbish because we were on different planets (R#63, Bachelor; Master; 2019).

Acknowledging the difficulties, multiple perspectives could however be a 'gift'; Respondent #81 articulated that although the challenges of DPS were "patience, listen-ing and learning" this encompassed "the gift of being challenged on my preconceptions/

prejudices" (Master; 1999). The responses suggest a transformed dispositional preparedness to listen to and engage with understandings contrary to one's own.

Social pressures can significantly influence the dynamic in collaborative groups, at times overshadowing learning (e.g., Carvalho, 2016; Christensen, 2016; Robinson, 2016). Although difficult, this intellectual conflict has the potential to enhance the outcomes of group cooperation (Johnson & Johnson, 2012). As one graduate surmised, the interplay of multiple perspectives "puts demands on your own ability to argue and communicate. It also offers the opportunity to understand things that are difficult" (R#18, Master; 2017). This reflects a pedagogical orientation that requires students to develop and articulate their own *profferings* in order to develop the courage to take up a position and stake a claim based in their own knowing (Barnett, 2009). Guided teaching strategies (such as Johnson and Johnson's (2012) structured debate) can scaffold students' attempts to reconcile alternative viewpoints and support them to develop the social and cognitive competence to constructively engage in — and learn from — intellectual conflict. To be most effective, social learning spaces depend on a sense of mutual respect and a shared commitment to learning (Acton & Halbert, 2018; Wenger, 2011). This creates a place where ideas are tested, qualified, argued, discussed, challenged, and contradicted — where students are invited to develop dispositional willingness to listen, share, and construct meaning collaboratively.

Knowing critically: Knowledge work processes that engaged students in multiple perspectives intertwined with an outcome where graduates felt they developed critical ways of engaging with knowledge. Quantitative survey responses reported that 61% of graduates felt that DPS supported their capacity for critical thinking, while 41% felt it developed their skills in analysis and evaluation. Criticality requires a capacity to evaluate and reconcile conflicting views, with an openness to diverse viewpoints, suspension of prior understandings, and non-egocentric reflection important in the process (Flores et al., 2012). This openness to alternative readings was seen in graduate statements that DPS enabled "critical analysis, the ability to see more options in the solution" (R#29, Master; 1981). Critical reflective thinking as part of engagement with others underpinned Respondent #217's statement that a strength was "interdisciplinary collaboration, [it] taught me to be critical and reflective in a factual way" (Master; 2019). Similarly, "[DPS] taught me to reflect upon a topic in a wider and deeper way. It developed my critical sense and horizon of understanding" (R#220, Bachelor; Master; 2016). The comments indicate critical thinking as an *epistemic* disposition, inseparable from students' multifaceted encounters with knowledge and others who think differently.

Graduates repeatedly connected their capacity for critical evaluation with engagement with plural, nuanced views about issues. This necessitated a thoughtful assessment of differing perspectives. An alumnus commented that the expertise gained through DPS involves "practise in collecting academic knowledge – and at the same time practising a critical perspective on academic knowledge" (R#31, Master's; 1978). Another recounted that the expertise developed included a "nuanced perspective on professional knowledge and concepts" (R#119, Master's; 2019). As Respondent #5 explained, DPS developed the ability "to be critical and solution oriented. Focus on the fact that there must be an outcome—not just a description" (R#5, Master; 2006). These perceptions reiterate other studies where problem-based approaches have been shown to support the development of criticality (e.g., González-Jiménez et al., 2016; Thomas & Depasquale, 2016) and that find critical thinking to support ethical judgements and decision-making in complex problem-solving (Carvalho, 2016; Tassone et al., 2018). It seems that this invites students to develop

an epistemic courage to make decisions based on knowledge-in-use. Further, there is an implied sense of intellectual humility in graduates' preparedness to set aside existing pre-conceptions in order to listen to and engage with ideas and beliefs that differ from their own.

Conclusion

Oriented in a theoretical understanding of knowing (and coming-to-know) and being (and becoming) as inseparable (Barnett, 2009; Stoller, 2014), in this article, I consider the entanglement between student working processes and learning effects. The case considers a pedagogical approach known as Danish Project Studies, a highly autonomous form of collaborative inquiry enacted at a Reform university in Denmark. The guiding research questions considered the outcomes of DPS in conjunction with associated practices of learning. Results from the case show that student academic achievement is higher in DPS, with alumni perceiving that problem-focused projects often allowed for enhanced learning (although these perceptions varied), describing the outcomes as *complex* and *critical* understandings of knowledge. These outcomes entwined with inquiry processes, where encounters with knowledge are *troublesome* and *contested*, enabling *immersive* and *multi-faceted* ways of working. An emergent curriculum, where content is not pre-determined or simplified by supervisors supports these work practices, situating students in the 'sweaty mess' of generating knowledge (Connell, 2019). At the same time, graduate statements indicate dispositional changes in their willingness to engage, their openness to alternative understandings, and their preparedness to collaborate.

There are limits to the discussion presented here. In particular, self-report data based on memory (in some cases long after graduation) is a proxy for the 'truth' of educational experiences (Denscombe, 2007; Thomas & Depasquale, 2016). While it does provide illustrations of those experiences and outcomes perceived as significant long after graduation, data from a small number of graduates and single cohort of students cannot be assumed to represent the whole. The distinction between DPS and course work in the achievement data is also more porous than indicated here, and grade differences may be due to other factors than those explored in this paper. In reality, elements of different pedagogic philosophies intermingle and co-exist in each stream, with traditional education also inviting students to develop dispositions which have not been explored. These limitations invite further research, especially in terms of comparing achievement patterns of additional cohorts, comparing data with that of other universities, and using performance-based assessment tasks to ascertain graduates' applied knowings, critical thinking competences, and problem-solving skills in practice would be of benefit the field (e.g., Klegeris et al, 2017; Shavelson et al, 2018). What the study offers, despite these constraints, is rich insight into the longitudinal effects and associated knowledge work processes of iterative implementations of inquiry-based approaches at the institutional level. Given the dearth of evaluative studies of this kind (Acton, 2019), this represents a meaningful contribution in the field.

Reform universities enact knowledge-work differently. In this alternative existence, they foster a 'conceptual spaciousness' about what universities are and what they might be, actively working to expand the collective educational imagination (see Barnett, 2013). In this way, studies of Reform universities' pedagogy and their effects are of global significance in higher education contexts that seek to implement approaches to curricula that orient students towards transformative engagements with knowledge (Connell, 2019). The

research presented here illuminates a select suite of the benefits and complexities of enacting an educational paradigm of *troublesome* and *contested* collaborative inquiry. It shows that while graduates may experience knowledge outcomes in a range of ways, collaborative DPS enables higher achievement and improved learning through the facilitation of deeply meaningful encounters with knowledge and others. The case speaks to the value of a kind of knowledge work where students practise (i.e. *do*) interested and inclusive ways of engaging with the world, inviting the development of dispositions that reflect a willingness to engage and a readiness to listen to and learn with others. It is in these transformative encounters that there exists the potential for broader societal change.

Data availability I confirm data and material is available with identifying data removed, in accordance with GDPR.

Code availability Not applicable.

Declarations

Ethics Ethical standards, including GDPR privacy requirements, were complied with in all aspects of the research.

Consent to participate In compliance with GDPR laws in Europe, student participants were emailed to inform them about the use of their anonymised data with an option to opt-out. No requests were received. Gradate participants indicated consent through completing the survey after being informed of the purposes and use of anonymised data.

Consent for publication In compliance with GDPR laws in Europe, student participants were emailed to inform them about the use of their anonymised data with an option to opt-out. No requests were received. Introductory survey material informational material explained the purposes of the study, that the data would be used for research purposes, and stated that the data used would remain anonymous.

Conflict of interest The author declares no competing interests.

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