A Comprehensive Hybrid and Flexible ('HyFlex') Course Architecture for Conceptual Modelling Courses in Information Systems

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Abstract

'HyFlex' is a catchword for course designs in higher education that provide students with the opportunity to attend course sessions in-person as well as remotely ('hybrid') and to change the mode of attending every week based on their circumstances and preferences ('flexible'). Due to the need to teach the complex skill of conceptual enterprise modelling (CEM) through practical exercises and feedback, HyFlex course designs for CEM courses pose several challenges to typical CEM-related learning outcomes. This paper proposes a set of design requirements, principles, and features for a comprehensive HyFlex course architecture for CEM courses. The design requirements, principles, and features evolved through and are evaluated against several iterations of CEM courses across two different programmes (undergraduate and postgraduate), student numbers (ranging from 17 to 121), settings (lecture & workshops, block mode, etc.), and course topics (business process and enterprise architecture modelling). The student performances and course evaluations indicate that the offered courses that instantiated the presented course architecture have been both effective and appreciated by the students. Other instructors can draw on our course architecture to design or adapt their own CEM courses – but also, to an extent, courses with other topics – to the HyFlex paradigm.

Keywords Teaching, HyFlex, Hybrid course, Flexible course, Conceptual Modelling.

1 Introduction

'HyFlex' – a portmanteau of 'hybrid' and 'flexible' – is an umbrella term used by Beatty (2019) for course designs that enable students to choose flexibly between in-person and remote participation modes throughout a course, without missing out on content or engagement opportunities regardless of their chosen participation mode in a given week. This inherent flexibility offers further advantages, such as reaching a wider range of students than those in a traditional full-time on-campus study mode and providing students additional flexibility in completing a course in light of changing life circumstances. Simultaneously, HyFlex courses

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tend to require a higher effort on the faculty and administrative side regarding preparation and delivery compared to traditional on-campus teaching arrangements (Beatty, 2019).

Conceptual enterprise modelling (CEM) courses – which cover subjects such as business process (BP), data, systems, or enterprise architecture (EA) analysis, modelling, and design – often incorporate 'hands-on' exercises with feedback cycles to help the students attaining modelling proficiency in the chosen conceptual modelling language (Bandara et al., 2010; Recker & Rosemann, 2009). These feedback cycles can, for instance, take place in small tutorials accompanying a traditional weekly lecture or in flipped classroom settings (Tanner & Scott, 2015). In a HyFlex course design, retaining these synchronous in-person interaction spaces can be a useful course design component, but alternative arrangements need to be made for students participating remotely. Hence, HyFlex usually cannot be just an 'add-on' to an existing CEM course but requires a more fundamental rethink of the entire instructional design and the best ways of attaining the course learning objectives (Beatty, 2019).

The authors have been fortunate to have, at the time of writing, gone through several iterations of HyFlex CEM courses in the years 2020-2024 across two topics (BP and EA modelling) in two different Information Systems (IS) programmes (undergraduate and professional master) at the same university. While during the global pandemic in-person instruction was possible and had taken place with very few exceptions from the second half of 2020 onwards, the university leadership also mandated until the end of 2022 that it shall be possible for all students to complete any course fully remotely. Many course iterations had several students unable to attend any in-person sessions (e.g., due to being in different parts of the country or entirely different countries). Hence, the authors chose to go for full HyFlex course designs for their courses and have evolved the underlying course architecture over the years.

This not only allowed the authors to adapt to changing circumstances over the subsequent years rather easily, they also have found that the HyFlex conversion and refinement efforts led to an overall shift in teaching practices away from the traditional 'course monolith' where the main emphasis lies on shaping the form of synchronous in-person teaching and learning for a few hours each week (e.g., lecture and tutorial). Our experiences and the corresponding reflections on our evolved teaching practices thus allow us to answer the following research question in this paper: *What are design requirements, principles, and features for effective and appreciated HyFlex courses on conceptual enterprise modelling topics?*

We understand effectiveness as the extent of students attaining the course learning objectives and use metrics such as final letter grades and their medians as proxies for measuring effectiveness, as these letter grades result from the assessment of the students' submissions to assignments that are aligned to the course learning objectives. To measure appreciation, we use the scores and feedback taken from the aggregated results of the anonymous course and teaching evaluation surveys submitted by the students towards the end of the courses as proxies.

In contrast to the four main – but, in the end, partial – themes (tool support, feedback for students, learning analytics, and gamification) in the teaching conceptual modelling literature identified by a structured analysis (Rosenthal et al., 2019) we instead intend to contribute a holistic yet abstract and thus re-usable and adaptable course architecture with this paper. We use the term course architecture to indicate that we do not intend to provide a turnkey course design as our main contribution, or, in the words of Nicolai and Seidl (2010) directly applicable instrumental relevance. Instead, we aim for conceptual relevance (ibid.) to guide and inspire educators to draw on our (more abstract) design principles and (more specific) design features for teaching CEM in a HyFlex setting when considering a (re)design their own CEM – or possibly other – courses to make them partially or fully HyFlex. We thus intend to contribute *not* explanatory knowledge for theoretical advancement, but prescriptive knowledge (or knowledge for design and action) (Gregor, 2006; Gregor & Hevner, 2013) instead to improve the course design and teaching practices for higher education courses.

We further deliberately avoid having a broader spectrum of topics for the courses that we cover, partially because the authors' teaching is focused in the CEM areas, but also to limit the variety of other factors affecting the course architecture and its outcomes. Among the evaluation of the more abstract design principles, we nonetheless reflect on the projectability of these design principles into context beyond CEM and HyFlex.

2 Conceptual Foundations

2.1 Conceptual Enterprise Modelling as part of Information Systems Curricula

Traditionally, conceptual enterprise models have been defined as "a computational representation of the structure, activities, processes, information, resources, people, behaviour, goals and constraints of a business, government, or other enterprise." (Fox & Grüninger, 1997). Conceptual enterprise models typically represent an enterprise from different perspectives, from the as-is to the to-be, allowing for analysis of the current situation, consideration of future scenarios, and communicating with stakeholders (Bjeković et al., 2014; Fox & Grüninger, 1997). The representative nature of a conceptual enterprise model is commonly conceptualised as a script that follows a certain grammar and is built following a certain method within a given context (Recker et al., 2021; Wand & Weber, 2002).

In an increasingly interconnected digital world, the scope of these models can extend beyond enterprises to business ecosystems (Drews & Schirmer, 2014) and other, non-work settings (or even parts of society). They further have the purpose not only to represent but also to shape the future physical as well as the digital reality, and to mediate between these two realms (Recker et al., 2021). In other words, the role of a conceptual enterprise model is to help human as well as digital agents in a model-driven analysis, design, operation, and governance of enterprises and other socio-technical systems. Different types of models exist with varying emphasises on sub-sets of these socio-technical system, including data, BP, or EA models.

The task of creating conceptual enterprise models relies on the modellers' constituent knowledge about and skills in executing the activities of *understanding* (the real-world application domain), *conceptualising* (formalising the parts of interest in the application domain), *abstracting* (from specific details and problems), *defining* (the main concepts to be used for modelling), *constructing* (the model itself as a simplified representation of the real world), *evaluating* (the model with respect to certain qualities), and *refining* (the model, based on the evaluation results) (Thalheim, 2010). We would add *communicating* (to other modellers as well as to stakeholders) (Hoppenbrouwers, 2012; Hoppenbrouwers et al., 2005) and – in a somewhat extended perspective beyond 'pure' modelling – *utilising* (e.g., for analysing or governing the current or shaping the future physical and/or digital reality) as two other important tasks in the wider context of CEM.

CEM courses are an integral part of recommended curriculums for Information Systems programmes (Jung & Lehrer, 2017; Leidig & Salmela, 2021) and also part of many university courses (Eduglopedia, 2022) – here often as a means to an end to conduct e.g., business process management. In the competencies outlined in the IS2020 Competency Model for Undergraduate Programs in Information Systems (Leidig & Salmela, 2021), CEM-related competencies play a role in the three domains of Development (i.e., conceptual system models as a foundation for systems development), Organization (i.e., conceptual business models as a foundation for business process management), and Data (i.e., conceptual data models as foundation for database and analytics systems). All nine skills discussed above are relevant in all these domains and thus cut across the competencies in the IS2020 model curriculum.

The authors had been teaching several courses on two specific CEM forms (BP and EA modelling) for several years before transitioning to a HyFlex course design. These courses have generally followed what can be considered a traditional approach to learning CEM such as the one outlined by Recker and Rosemann (2009): weekly formal lectures (for two hours), weekly practical workshops (for one hour), and reflective and formative assessments (quizzes and two assignments in their example), the latter including group work. However, in order to develop the requirements of CEM courses for a HyFlex format more substantially, we first need to unpack the foundations of teaching CEM as well as the HyFlex foundations.

2.2 Teaching the Complex Task of Conceptual Enterprise Modelling

While the act of CEM can be analytically decomposed into the nine activities outlined in the previous section (understanding, conceptualising etc.), their application in practical CEM (whether as part of exercises or a real-life modelling task), however, takes place in a varied and also often creative way that is more than the 'sum of these (nine) parts'. Trying to learn such 'parts' in isolation will most probably be ineffective for learners when the ultimate goal is to learn the complex task (Kester & van Merriënboer, 2021) of CEM. Hence, in this paper we forgo a comprehensive distinction of different knowledge types in the CEM context as e.g., in Bloom's revised taxonomy (Krathwohl, 2002) which is otherwise commonly used in education papers (see also Darwazeh's (2017) criticism of common applications of Bloom's taxonomy).

Instead, we put the complex task of CEM at the centre of the desired learning outcomes and therefore understand teaching CEM as an instance of 'complex learning' in the sense of Kester & van Merriënboer (2021) and their four-component instructional design (IC/4D) model (initially introduced in the early 1990s). In a nutshell, the IC/4D model is about acquiring skills for real-life task performance and, at its core, recommends to consider four components in the resulting instructional design: learning tasks, supportive information, just-in-time information, and part-task practice (Kester & van Merriënboer, 2021).

The following four sub-sections give an overview of these four components and their application to CEM course design. Here, we draw on extant distinctions of CEM-relevant knowledge types (Bork, 2019). We will build upon these foundations later when we detail the design requirements, principles, and features of our HyFlex CEM course architecture.

2.2.1 Learning Tasks

Learning tasks should engage learners to perform the constituent skills of the complex skill that they shall become proficient in. For each different class of learning task involved, these learning tasks should advance from simple to more complex tasks over time while simultaneously reducing the learner support provided alongside. Learner support for each task can be provided process or product-oriented (e.g., how-tos or examples, respectively). Alongside the learning tasks themselves, the criteria for an acceptable goal state for each outcome need to be specified.

The task classes in a CEM course are defined by the desired learning outcomes, e.g., attaining modelling proficiency in one or more conceptual modelling languages (e.g., Business Process Model and Notation (BPMN) or ArchiMate) or diagram types (e.g., the different EA viewpoints). While Recker et al. (2021) emphasise the role of the models (scripts) over the underlying languages (grammar) in conceptual modelling practice, we nevertheless regard attaining proficiency in languages as well as basic modelling principles as equally important for university-level courses. For each task class, the learning tasks should therefore progress from simple to more complex modelling tasks.

Modelling complexity can be expressed in the range of the nine CEM activities outlined above (understanding, conceptualising etc.) and thus should progress from *understanding* simple domains and *conceptualising* these through *constructing* simple *representations* without the need to *communicate* to more complex settings and representations which may also involve the need to *communicate* among several modellers or with stakeholders, or *utilising* the models for subsequent analysis and/or design assignment tasks.

2.2.2 Supportive Information

Supportive information comprises all information the learners need to advance from their current state of knowledge to what they need to know to successfully tackle the next learning task. The latter could comprise a more complex task of the same learning task class or an entirely different task class. Supportive information comprises information provided in advance of but also after a learning task (e.g., feedback).

For teaching CEM, supportive information presented in advance will mainly be about the grammar (syntax and semantics) of the chosen modelling language: its purpose, goals, constructs, and relationships as well as the ways how modelling in general or with the specific language can and should take place. A second important part of supportive information is the feedback provided to the outcomes of previous learning tasks: what parts were well executed and where was room for improvement?

2.2.3 Just-in-time Information

In contrast to the more 'timeless' supportive information, just-in-time information is more about step-by-step knowledge the learners need to perform the constituent skills required to master the complex learning task at hand. As a learner becomes more proficient with the skills, just-in-time information becomes less important over time.

Just-in-time information for CEM courses can comprise modelling examples, demonstrations, step-by-step how-tos of constructing representations, or checklists to evaluate the quality of a model. Immediate process-oriented feedback during the modelling (e.g., error messages in a modelling tool) is also part of the just-in-time information.

2.2.4 Part-task Practice

Part-task practice becomes relevant only if a very high level of automaticity is required to perform the complex task in practice (e.g., playing scales on musical instruments or pilot reactions in emergencies).

We do not regard part-task practice (e.g., on the foundational aspects of modelling or the chosen modelling language) as being particularly crucial for CEM courses as modern digital modelling tools give modellers ample support during modelling. Moreover, the respective foundational skills can also be developed through feedback to the regular learning tasks, especially if there are very simple learning tasks at the beginning for each task class.

2.3 Foundations of HyFlex Course Design

As the hallmark of the CEM course architecture in this paper is its HyFlex nature, we now outline the foundations of designing a higher education course according to HyFlex principles.

With students having to juggle multiple life roles when studying, which can include working, and family responsibilities, they are looking for more flexibility in the way they learn (Abdelmalak & Parra, 2016). The COVID-19 global pandemic in the early 2020s has also shown the need for universities and lecturers to increase resilience against unexpected events through more flexible course delivery options (Keiper et al., 2020). In these contexts, Hybrid-Flexible (HyFlex) course designs as suggested by Beatty (2019) (initially introduced in 2006) can be attractive approaches to address these challenges as it is a combination of hybrid learning and flexible learning (Malczyk, 2019).

HyFlex course design caters for present as well as distant students enrolled in a single course (Abdelmalak & Parra, 2016; Keiper et al., 2020). HyFlex moves beyond a traditional blended learning approach (Abdelmalak & Parra, 2016) to one that uses "hybrid classes (blending online and classroom participation modes) to provide flexible learning paths and allowed students to decide for themselves which path was 'best' for them on a daily or weekly basis." (Beatty, 2019 p. 20). This inherent flexibility across the entire course is what sets HyFlex courses apart from other blended or hybrid offerings.

The goal is thus to provide students with the options to be able to participate in their course based on their preferences and needs in any given week, i.e. they can attend any class either face-to-face or online, and either asynchronously or synchronously (Beatty, 2019; Keiper et al., 2020; Miller et al., 2013). Thus, adopting HyFlex can help provide better access, convenience, and flexibility to support students (Abdelmalak & Parra, 2016). In particular, HyFlex course design is built upon four values (Beatty, 2019 p. 52). These values encompass basic qualities that all HyFlex courses should adhere to.

1. *Learner Choice*: provide meaningful alternative participation modes and enable students to choose between participation modes daily, weekly, or topically
2. *Equivalency*: provide learning activities in all participation modes which lead to equivalent learning outcomes
3. *Reusability*: utilise artefacts from learning activities in each participation mode as 'learning objects' for all students
4. *Accessibility*: equip students with technology skills and equitable access to all participation modes.

It is also important to keep in mind that regardless of which participation mode a student engages with, teaching and learning activities should present content effectively and professionally, engage learners with productive learning activities, and use authentic assessment to evaluate student learning (Beatty, 2019).

The HyFlex approach has been adopted for a wide range of different types of courses for both undergraduate and postgraduate students. For example, Binnewies and Wang (2019) used it to teach undergraduate students information security and information management; Malczyk (2019) used it to teach undergraduate students in a social welfare policy course; Miller et al. (2013) used it to teach postgraduate students in a statistics course; and Keiper et al. (2020) used it to teach undergraduate and postgraduate students across courses that included organisational behaviour, introduction to sport management, marketing management, and human resources. However, to the best of our knowledge, a HyFlex course architecture for a CEM courses has not been documented yet. This provides an opportunity to codify our experience in this paper in the form of a set of design requirements, principles, and features for a comprehensive HyFlex course architecture for CEM.

During the development of a HyFlex course design, several aspects need to be considered. While the instructor(s) must still provide the course content and create activities to meet the goals of the course syllabus, they must ensure that students have a choice on how they access this content and participate in activities in any given week. In other words, both face-to-face and online modes must be available for all student engagements within the course (Beatty, 2019) in a way that provides equivalency (Miller et al., 2013). That is, students must be able to consume the course content and participate in activities regardless of whether they are attending the course online, face-to-face, or in some combination of the two (Beatty, 2019). Further, any activities that generate learning resources – i.e., video recordings, presentation files, or discussion notes – should be captured and made available for reuse by the students. Lastly, to ensure accessibility, students must be equipped with the technological skills required to access the participation choices (Beatty, 2019). When considering these aspects, it is important to keep in mind that active learning strategies for student engagement (such as classroom response systems and collaborative activities) may differ across delivery modes, meaning student engagement measures may need to be customised depending on the delivery mode being offered (Binnewies & Wang, 2019).

2.4 The Challenges of Teaching CEM in a HyFlex Environment

The question now arises what the specific challenges are that arise when a CEM course is to be offered in a HyFlex format.

As CEM takes place between the cognitive processes in the modellers' / learners' heads and a digital tool (or paper), on first glance only the *evaluating* (by a more experienced person) and *communicating* CEM activities (cf. section 2.1) seem to be affected by a loss of synchronous in-person interactions. Expanding the perspective towards the IC/4D components, however, all three relevant model components (learning tasks and the provision of supportive and just-in-time information) are affected. While the task of learning CEM is, in essence, independent of space and time (i.e., students can perform the CEM exercises and assignments anywhere and at any time), it is the corresponding information provision that in traditional course designs relies on face-to-face interactions between learners and teachers (and potentially between learners as well). Here, the challenge though is to find adequate replacements for these interactions that can take place asynchronously and/or on-line while not becoming too detached or distant from the learning tasks themselves, for instance, in the case of feedback.

Existing literature that covers a similar challenge is one on converting an existing conceptual modelling course into a more blended learning format building upon technology suitable to deliver Massive Open Online Courses (or MOOCs) (Bogdanova & Snoeck, 2018). Key aspects of such a transition included providing videos of live lectures and formative assessments in the form of interactive on-line quizzes with immediate feedback.

However, as Bogdanova and Snoeck (2018) note themselves, the quality of recorded lectures may not always be ideal. Moreover, the availability of recordings may lead some students to 'procrastinate' their engagement with the course materials to an extent that negatively affects their performance. These aspects are therefore two more crucial issues our course architecture needs to tackle.

3 Methodology

Since design science in Simon's (1996) tradition is also applicable to teaching and course design (Laurillard, 2013), we use the established design science research (DSR) trifecta of design requirements, principles, and features (Drechsler & Hevner, 2022; Meth et al., 2015; Vom Brocke et al., 2020) to generalise from our specific course offerings (see the next section for further details) to a more general class of CEM course contexts. Here, we see each instance of a HyFlex CEM course offering as an artefact instance, and the design principles and features as abstractions and generalisations over each course offering. The details of each course offering are documented in the archived course outlines on our university website: https://www.wgtn.ac.nz/study/programmes-courses/courses.

Note that we did not follow a dedicated design science research process when developing and refining our course designs and the generalised course architecture over the years 2020-2024. Instead, there was an ongoing co-evolution of course (re)designs and corresponding generalised insights that the two authors shared between themselves to inform future course (re)designs. We nevertheless draw on established means to communicate design knowledge in design science such as design requirements, principles, and features. We further only present the final version of the course architecture and only highlight any substantial variations or changes over time. We will further reflect on the implications of our findings beyond HyFlex CEM university courses in the final sections of the paper.

Table 1 details the roles of design requirements, principles and features in general and how we use them to document our HyFlex CEM course architecture in this paper. We ground our course designs (and thus our generalised course architecture as well) on the established knowledge base on teaching the complex task of CEM (cf. sections 2.1 and 2.2) and designing HyFlex courses (cf. sections 2.3 and 2.4). We further draw on one author's previously documented design knowledge for changing an enterprise modelling course from a traditional delivery model to a fully online course (Drechsler, 2021). Since our course architecture is generalised from actual CEM course offerings, we can evaluate the design principles and features against these varied naturalistic settings (Venable et al., 2016). Each evaluation data point for a specific course offering serves simultaneously as a summative evaluation of that particular offering as well as a formative evaluation of the underlying course architecture itself which the course has been based on. Specifically, to support our claims in this paper in terms of course effectiveness, we use course pass rates and median grades combined with selected qualitative insights about the course difficulty and the quality of the assignment deliverables. We further draw on selected course evaluation scores and anonymous student comments made in these course evaluations to underline the extent to which our course designs have been appreciated by the students with respect to key factors with relevance for a HyFlex context. We are aware that these measures can only serve as proxies for effectiveness and appreciation and reflect on the corresponding limitations towards at the end of the paper.

Concept	Description	Role in the course architecture
Design Requirements	Design requirements capture the characteristics a design artefact needs to fulfil to address a real-world problem.	Our design requirements document the specific needs for a CEM course in a HyFlex format to be both effective and appreciated.
Design Principles	Design principles codify actionable knowledge to address a real-world problem on a general level, independent of artefacts. Design principles can be particularly helpful when projecting design knowledge into contexts that differ more substantially from the context the knowledge (or artefacts) have been designed for.	We use design principles to codify course design characteristics on a mid-range level of abstraction, independent of specifical instructional or technical solutions. Our design principles can potentially be useful when applied to conceptual modelling (or even any other type of) courses outside of enterprise modelling, IS programmes, or university courses.
Design Features	Design features are an abstraction over design artefacts and highlight those characteristics of design artefacts that implement the design requirements in order to achieve the intended outcomes (Lukyanenko & Parsons, 2020). Design features are more specific than design principles and allow for an easy knowledge transfer to artefacts in similar contexts.	We use design features to capture and isolate key specific characteristics of our course offerings that meet the specified requirements. The design features can be potentially useful when looking for specific ways to (re)design CEM courses in IS programmes in other universities to bring them more into line with the HyFlex requirements.

Table 1. Roles of design requirements, principles and features in the HyFlex CEM course architecture

4 Context: The Course Settings

This section gives an overview of the range of contexts for which we designed our HyFlex course architecture. All courses were offered in bachelor or masters level IS programmes by the same public university in the Australasian region. All courses had taken place during a regular trimester over 12 weeks (2x 6 weeks with a 2-week break in between). Note that the masters programme is a professional conversion masters for students with non-IS undergraduate degrees.

The specific circumstances in this masters programme from the second half of 2020 onwards required an equivalent learning experience of on-campus and remote/ overseas students together with an improved resilience against any operational disruptions caused by the then-ongoing pandemic. This situation prompted us to adopt a full HyFlex approach for those courses. Buoyed by the resulting transformation of the 2020 courses, the first author adopted the same HyFlex course architecture to his undergraduate courses in the subsequent years.

Table 2 summarises the key course characteristics over the years. Further information such as detailed student demographics are unfortunately not available.

As one can see from Table 2, there are considerable differences over the years between the courses in terms of student numbers, the number of off-campus students, and the courses' means of delivery. The undergraduate courses (or rather, the in-person parts) were scheduled in a traditional lecture-and-workshop format. In contrast, the in-person parts for the master's courses were scheduled in a block format with a single – but potentially longer – session each week until 2023. Then, the delivery format switched to a more elaborate configuration as part of the need to scale up to reflect the substantially increased student numbers. The BP modelling courses relied on an established textbook (Dumas et al., 2018) and focused on the BPMN language. The EA courses were supported by a self-developed EA modelling guide based on the TOGAF framework and the ArchiMate language. Further details about the course characteristics and delivery are covered among the design features of our course architecture in sections 5.1.3, 5.2.3, and 5.3.3 below.

Course Code & Year(s)	Course topic	Programme	# Students enrolled	# Students off-campus	Weekly Schedule
INFO 234 2021 2022	Business process modelling	undergraduate	121 (2021) 112 (2022)	5 (2021) 14 (2022)	2h lecture & small 1h workshops
MBUA 511 2020 2021 2023 2024	Business process modelling	professional conversion master	24 (2020) 18 (2021) 64 (2023) 47 (2024)	9 (2020) 8 (2021) 0 (2023) 0-4 (2024)[1]	2020-2021: Weekly 2h block for all students 2023-2024: ~60 min plenary session & 15 min coaching session per team
INFO 376 2021 2023	Enterprise architecture modelling	undergraduate	89 (2021) 69 (2023)	9 (2021) 0 (2023)	2h lecture & small 1h workshops
MBUA 514 2021a[2] 2021b 2022 2023 2024	Enterprise architecture modelling	professional conversion master	26 (2021a) 17 (2021b) 22 (2022) 63 (2023) 48 (2024)	9 (2021a) 10 (2021b) 10-13 (2022)[3] 0 (2023) 0 (2024)	2021-2022: Weekly 2h block for all students 2023-2024: ~60 min plenary session & 15 min coaching session per team

Table 2. Course characteristics

5 A HyFlex Course Architecture for Teaching Conceptual Enterprise Modelling

This section presents our course architecture for CEM courses by outlining the underlying design requirements, the design principles for the solutions, and specific design features in our courses. Figure 1 summarises our course architecture in an overview.

Figure 1 shows the design requirements, principles, and features sorted into three areas which were inductively created based on a minimum overlap of design features and relationships across the areas. The first area is centred around the learning outcome (i.e., attaining proficiency in the complex skill of CEM), the second one around enabling the necessary communication paths for information exchange, engagement, and interaction in HyFlex contexts (implementing the original HyFlex *learner choice* and *equivalency* values), and the third one around the operational resources needed to build and run a HyFlex course, digital or otherwise (implementing the other two HyFlex values: *accessibility* and *reusability*).

[1] As there were substantial delays in visa approval in Q1 2024, a number of overseas students had to participate remotely for the first few weeks of MBUA 511 until they arrived in the country. There were several more students who had to defer to a later enrolment date; these are not counted here.

[2] This course was offered in the first (2021a) and third (2021b) trimester of 2021.

[3] As travel restrictions became relaxed over Q3 2022, a few overseas students could become in-person students during the trimester where MBUA 514 was offered.

Each area is detailed in its own sub-section in terms of its design requirements and their rationales, and the corresponding design principles and features. The design requirements and rationales are based on the nature of CEM courses, the HyFlex values as outlined in the second section, and the specific characteristics of our course contexts (as outlined in the previous section). The design principles address general course design considerations whereas the design features allow us to provide additional rich insights based on our individual experiences and specific circumstances.

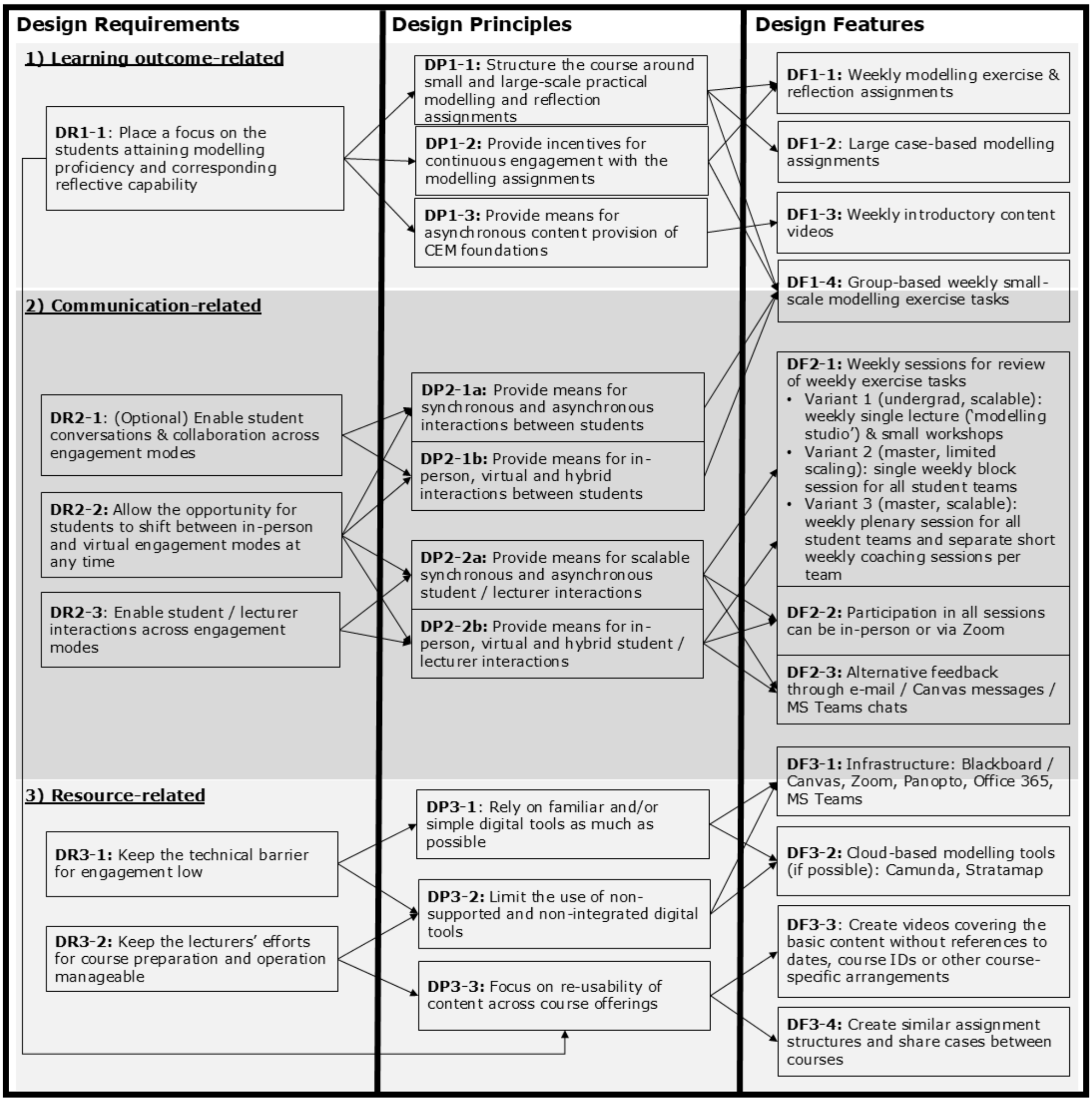

Figure 1: Design requirements, principles and features of our HyFlex course architecture for CEM courses

Note that Figure 1 does not show all relations between design requirements, principles, and features mentioned in the detailed tables in the sub-sections in order to avoid an 'overload of arrows' in the figure. Instead, we focus on those relationships we deem to be the most essential.

5.1 Learning Outcome-related Course Architecture Components

First, we tackle the design requirements, principles, and features related to learning outcomes of gaining proficiency in the complex skill of CEM.

5.1.1 Design requirements

For the learning outcomes, we formulate a single focused design requirement.

DR1-1: *Place a focus on the students attaining proficiency in the complex skill of conceptual modelling and corresponding reflective capability*

The underlying rationale behind this design requirement is that the emphasis in CEM courses commonly lies on achieving modelling proficiency, along with reflections on limitations or implications for subsequent analysis tasks (cf. section 2.1). Therefore, this key requirement is carried over unchanged compared to a traditional non-HyFlex CEM course.

5.1.2 Design principles

To implement the design requirement DR1-1, we formulate three design principles.

DP1-1: *Structure the course around small and large-scale practical modelling and reflection assignments*

As outlined above, the IC/4D model puts the complex learning task – attaining CEM proficiency – at the centre of attention and treats information provision secondary. Adapting the recommendations given in Kester & van Merriënboer (2021) to teaching CEM leads to this design principle recommending a scaffolding structure of learning tasks (exercises & assignments) escalating in complexity over time. Moreover, having smaller-scale exercises and larger-scale assignments also gives purpose to the provided content. In other words, for the students, the content is important in a short-term perspective to gain 'points' (as per DP1-2 below). This design principle remained unchanged throughout the evolution of our course architecture and, in fact, could even be generalised from established traditional course designs such as our own of the past or the one documented by Recker and Rosemann (2009).

DP1-2: *Provide incentives for continuous engagement with the modelling assignments*

This design principle serves to incentivise regular student engagement throughout the course to support them in attaining modelling proficiency and ongoing reflection. This design principle also remained unchanged throughout the evolution of our course architecture and was, in fact, one characteristic that made our very first iteration of a CEM course – which was a fully virtual and asynchronous precursor, so to speak – effective in early 2020 (Drechsler, 2021). This DP also helps overcome one of the major challenges identified by Bogdanova and Snoeck (2018), an increased danger of student procrastination when digital resources such as lecture recordings become and remain available until the end of the course.

DP1-3: *Provide means for asynchronous content provision of CEM foundations*

As content provision in the IC/4D model is just a means of providing the necessary supporting information to enable the students to tackle the learning tasks, we consider an asynchronous content provision to be suitable. The focus here should be on providing 'sufficient' supporting and just-in-time information for the students to tackle the next learning task(s), tailored to the level of proficiency they have already attained.

A synchronous option would be possible, of course, but only complementary and with some added benefits (such as having the opportunity to ask immediate questions or providing a structured weekly time and space when to engage with the content). Asynchronous content provision has the advantage that the students can review the content whenever necessary during their exercises. It also allows reusability (and potential refinement of content) for the lecturers. While the previous two design principles would also apply to traditional CEM course offerings that have been mentioned, this one is specific to a HyFlex course.

5.1.3 Design features

There are four even more specific design features we used to implement the design principles in the past course offerings listed in Table 2.

***DF1-1**: Weekly modelling exercise and reflection assignments*

***DF1-4**: Group-based weekly small-scale modelling exercise tasks*

For most weeks, our courses had weekly exercise assignments, which were centred on the application of each week's new content. In all courses these built on a single (usually small) case and the exercises were designed to advance the students' modelling, analysis and redesign proficiency each week. In total, these weekly assignments accounted for 15-25% of the course marks.

The students worked in groups on these exercises but had to submit individual reflections and insights into the group work alongside the weekly exercise deliverables themselves. Hence, the assignments could be assessed individually. To keep the students' weekly workload in check, we also emphasised in later iterations of our courses that merely 'good draft versions' would be the expected standard for the weekly exercises and used the mantra 'copper, not gold' (provided in meme form for extra 'stickiness') to underline this expectation.

While we carried over the general approaches to graded weekly exercises and group work from previous traditional offerings, the exact number and percentage of those assignments were subject to constant adjustment for each course from one iteration to the next.

Note that this design feature also implements the student interaction-related design principles **DP2-1a** and **DP2-1b** (see next section).

***DF1-2**: Large case-based modelling assignments*

To assess the students' capabilities in mastering the complex skill of CEM for more complex cases, each course also had one large case-based assignment. There was a deliberate big overlap between tasks and questions between the weekly exercises and the case-based assignment; the key difference was the scale and complexity of the situation where the students were asked to apply their skills.

The case-based assignment was split into two or more portions (= smaller assignments about the same case throughout the term) to make the assignment appear less daunting, allow for feedback loops, lower the risk from the students' perspective, and distribute to the marking effort on the lecturers' side over the entire term. Each of those smaller assignments, however, built upon the previous one, so that there was one coherent arc from initial modelling over analysis to a redesign in each course, mirroring real-life organisational transformation projects that draw on conceptual enterprise models. Such an approach addresses the shift in conceptual modelling from merely representing to shaping the future of physical and digital organizational reality (Recker et al., 2021). This design feature was also carried over from pre-HyFlex CEM course offerings and continuously refined between course iterations.

DF1-3*: Weekly introductory content videos*

The supporting information (e.g., introducing new modelling language elements, diagrams, techniques, or analysis methods) was provided in the form of 3-8 videos each week. Each video usually had a length between 3 and 15 minutes (with a few exceptions). The videos were made available early Monday mornings in most cases. Interestingly, the students in one EA course requested the videos to be available Sunday evening instead – which was no problem on our end. Further, we could re-use several videos not only in future offerings of the same course, but – due to overlapping content – also in future offerings of a similar course on different levels (undergraduate / graduate).

For the undergraduate courses, the same content was delivered live during the weekly two-hour session (which we called 'modelling studio' instead of 'lecture'). Here, most sessions consisted of an alternating rhythm between short content provision (similar to a single video) and then time for group work on the weekly exercises in the lecture theatre. We thus ensured the equivalency of synchronous in-person and asynchronous engagement. This general rhythm of alternating short lecturing stints and time for group work already existed in pre-HyFlex iterations of our CEM courses and lent itself very well to the transition into short weekly videos covering the necessary supporting information.

5.2 Communication-related Course Architecture Components

This section covers the design requirements, principles and features related to the various engagement and interaction modes implementing the four HyFlex values.

5.2.1 Design requirements

First, we formulate three design requirements for the various modes of interaction between students and lecturers.

DR2-1*: Enable student conversations & collaboration across engagement modes*

This is an optional requirement strictly speaking, but relevant for us since we deemed it to be important for the students to have good conversations in their groups while constructing their conceptual enterprise models for their exercises and assignments. In line with the HyFlex values of *learner choice* and *equivalency*, these interactions should be possible regardless of each student's chosen engagement mode at a given time.

DR2-2*: Allow the opportunity for students to shift between in-person and virtual engagement modes at any time*

Learner choice and *equivalency* are two cornerstones of a HyFlex course design – being hybrid as well as flexible between in-person and virtual engagement modes – and this is thus the corresponding design requirement.

DR2-3*: Enable student / lecturer interactions across engagement modes*

Student / lecturer interactions are important for CEM courses as they encompass the provision of the learning tasks, the supporting information (e.g., the foundations and the feedback to exercises), and the just-in-time information (e.g., ad-hoc guidance or answers to CEM questions). Following the HyFlex values of *learner choice* and *equivalency*, these interactions should be possible regardless of the chosen engagement mode for either role at a given time.

5.2.2 Design principles

We formulate four design principles to implement the three design requirements: two for the interactions between students and two for the interactions between students and lecturers.

DP2-1a: *Provide means for synchronous and asynchronous interactions between students*

DP2-1b: *Provide means for in-person, virtual and hybrid interactions between students*
These two design principles implement DR2-1 and DR2-2 and are thus – like DR2-1 – optional. As outlined in the second section, however, we consider communicating between modellers or between modellers and stakeholders to be key aspect of CEM in practice and therefore include and implement these design principles. In a teaching environment, having students working together in groups can provide both structure for their efforts and a forum to discuss questions (e.g., around conceptualising, abstracting and constructing) among themselves. If the submitted assignments are assessed as group work, the marking efforts for those assignments can be reduced as well. HyFlex implies that there needs to be a variety of channels for interactions across student engagement modes. Therefore, this design principle has its roots in the teaching CEM aspect as well as the HyFlex aspect of the course.

DP2-2a: *Provide means for synchronous and asynchronous student / lecturer interactions*

DP2-2b: *Provide means for in-person, virtual and hybrid student / lecturer interactions*

These two design principles implement DR2-2 and DR2-3 and are, unlike the previous two, not optional. Answers and continuous feedback to students about their modelling efforts as part of the supporting or just-in-time information are at least equally important than content provision, so the means to provide these are a crucial consideration. HyFlex implies that there need to be a variety of channels for answers & feedback. This design principle is among the less-specific ones for CEM but nevertheless crucial for a true HyFlex course.

5.2.3 Design features

We formulate three design features to implement the four design principles.

DF2-1: *Weekly sessions for review of weekly exercise tasks*

Over time, we ended up having three variants of this design feature, to account for the different course formats we employed over the years (cf. Table 2):

1. *Weekly single lecture ('modelling studio') & small workshops* (undergraduate, scalable): This is the variant we employed for the undergraduate course offerings – a standard format with a two-hour session (formally called a lecture but called 'modelling studio' by ourselves) and with small-scale workshops run by student tutors. This format is scalable, limited only by the size of the lecture room and the number of available student tutors.
2. *Single weekly block session for all student teams* (master, limited scaling): This is the variant we ran for the master level courses with enrolments up to 30 students. The single two-hour session started off with some short general remarks, live discussions and/or short exercises at the beginning, and then shifted to a 'visit' to each team to discuss their questions or give feedback to their draft exercises. The room was equipped with sufficient tables and screens ('pods') so that there could be an almost seamless interaction between in-person and remotely participating team members for both parts of each session. We kept the general remarks to a minimum, however, to maximise the question and feedback time about the produced models for the weekly exercises. This format's scalability is limited to the

number of physical 'pods' for teams and the 'waiting time' for the final team to get its turn for questions and feedback in the second part of the session.

3. *Weekly plenary session for all student teams and separate short weekly coaching sessions per team* (master, scalable): As the need arose to scale the master level courses to more than double the number of students from 2023 onwards, we spun off the two parts of variant 2's weekly block session into separate sessions: an one-hour weekly plenary session for all students with now more expanded general remarks, live discussions and exercises, and then a dedicated 15-minute time slot later on the day for each team for 'coaching', i.e., to give feedback to their exercise drafts and answer their questions. All other course elements remained the same. The scaling limitations here are only the room size for the plenary session and the number of 15-minute time slots for the teams.

Notably, in two of the undergraduate courses, until 2/3rds of the term had passed, roughly 50%-60% of students enrolled in the course had chosen to still attend the weekly two-hour session in-person or remotely despite the same content being available as videos at the start of the week. The advantage these students saw was that they could start on their weekly assignment right away in their groups (with a large extent of the synchronous participants being in the lecture theatre) while having the opportunity to ask questions and receive feedback on the spot. In addition, after the two-hour session, they would have already made some good progress on the exercises to submit for the weekly exercise tasks. Groups not participating in the synchronous two-hour session could then have the same opportunity to seek feedback in their small-group workshop later in the week, but they had to organise their group work themselves.

DF2-2*: Participation in block session / lecture & workshops can be in-person or via Zoom*

Each session was streamed live via Zoom (with access to the master level coaching sessions restricted just to the team members), and all except these coaching sessions and the undergraduate workshops were recorded and provided as a video the next day. Live lecture participation via Zoom in the undergraduate courses turned out to be the exception (except for one offering) since (or despite) this option being redundant to the videos which were available earlier and better curated. Since about a third of the students in the master courses with the block sessions were out-of-town students, they were regular participants in the block sessions via Zoom, however. In the scaled-up versions of the master courses, remote participation was more limited, mainly because all students were in the country. The advantage for hybrid participation for CEM courses is that they usually rely comparably little on discussion and other forms of engagement that would benefit from mutual interaction across the whole class but instead rely more on questions, feedback, and reflection on produced conceptual enterprise models specific to each student or group.

DF2-3*: Alternative feedback through e-mail / Canvas messages / MS Teams chats*

This design feature also overlaps with the technical resources and infrastructure covered in the next sub-section.

Besides the synchronous participation in the lecture, workshops, or block session, there was also the opportunity for each student and team to ask questions or seek feedback asynchronously on MS Teams, e-mails, or through messages on our learning management system Canvas after its introduction in 2023. For content-related questions in MS Teams spaces, we provided a weekly channel with a pre-made conversation for each topic of that week. Here, students could ask questions by replying to one of those conversations. In some of the courses with block mode, this saw a reasonable uptake each week for one student cohort, but much less for another student cohort. In contrast, hardly any of the undergraduate students ever asked a question by replying to those conversations.

In addition, the students could share drafts of their exercise deliverables with a request for feedback or ask questions through messaging in MS Teams. Uptake of this opportunity also varied quite a bit between courses and student cohorts. MS Teams also has the option for quick audio or video calls, but those were the exception as well.

5.3 Resource-related Course Architecture Components

The third area of our course architecture focuses on the operational and resource aspects for HyFlex delivery

5.3.1 Design requirements

DR3-1*: Keep the technical barrier for engagement low*

Following the *accessibility* value, HyFlex course designs require digital tools, and these should be enablers and not barriers for students. Moreover, following the *equivalency* value, these tools should ideally also work from within an in-person classroom setting for student teams who happen to be hybrid at a given time.

DR3-2*: Keep the teaching staff's efforts for course preparation and operation manageable*

Given the established preparation and delivery effort associated with HyFlex courses, keeping teaching staff's (and potentially tutors') workload manageable became its own requirement.

5.3.2 Design principles

DP3-1*: Rely on familiar and/or simple digital tools as much as possible*

This design principle implements DR3-1. HyFlex course designs require digital tools to enable asynchronous and virtual / hybrid channels. These should not be a barrier for student engagement, however. Bogdanova and Snoeck (2018) point out that a switch in digital learning environments for their course conversion was not appreciated by the students, underlining the need to seek out familiar digital tools. For teaching CEM, attaining proficiency in using industry-standard modelling tools can be part of the intended learning outcomes, however, and these may not always be simple and easy to use. Therefore, this DP should not influence the choice of the digital modelling environment best suited for the chosen modelling language(s) and course contexts (e.g., the need for collaborative modelling). For instance, in one of our courses, we had to switch from a cloud-based EA modelling tool (Stratamap) to a standalone tool (Archi) when the former was discontinued and therefore were forced to trade the benefits of a collaborative modelling tool for one that was somewhat easier to use but had a less advanced feature set in return.

DP3-2: Limit the use of non-supported and non-integrated digital tools

This design principle implements DR3-1 and DR3-2. Relying on proven and institution-provided digital tools in a HyFlex course design can limit the risk and also shift the burden for technical support away from the lecturer. Again, this DP may not apply to the choice of digital modelling environment which may well be a standalone or vendor-hosted cloud-based solution that is not integrated with university systems. In our case, with the large-scale shift to digital / hybrid instruction across the entire university in 2020, we made the deliberate choice to discontinue the use of digital tools (such as Slack) in our courses that back then were better suited to our requirements but not integrated with the university systems.

***DP3-3**: Focus on re-usability of content across course offerings*

This design principle implements DR3-2 as well as DR1-1. CEM languages and techniques are usually quite stable these days, so provided content can be 'timeless' to an extent. There should nevertheless be continuous improvement of the provided material, however. Recognising the preparation and ongoing efforts HyFlex courses demand from lecturers, an emphasis on re-usability became important. Therefore, an emphasis on re-usability can help reduce the preparation effort after the first round and also shift the focus to a continuous improvement of the ongoing course support effort against a stable content backdrop. We formulated this design principle after our first iteration as one author had to re-record a number of videos for a next iteration of an EA course.

5.3.3 Design features

***DF3-1**: Infrastructure: Blackboard / Canvas, Zoom, Panopto, Office 365, MS Teams*

In terms of infrastructure, we were lucky to be able to rely on an extensive suite of quite well integrated digital tools provided by our university. Blackboard was the established learning management system (LMS) used to provide all types of content (e.g., PDFs, recordings, readings) to the students until it was replaced by Instructure Canvas in 2023. Zoom was the designated tool for synchronous sessions and corresponding recordings, whereas Panopto served as the tool for asynchronous recordings as well as the provision of both recording types since it was integrated with Zoom as well as the LMS. Panopto also allowed for some basic video editing and provided auto-generated captions for each video for additional accessibility.

In addition, until the arrival of Canvas with its improved community features, each course had its own MS Teams space, and our digital solutions unit could automatically enrol all students of a course in the course-specific MS Teams spaces, thus avoiding the need for manual signups by the students. MS Teams could provide a basic means for the students to collaborate with one another, but they often chose their own communication platforms such as WhatsApp, FaceTime or even Discord – a factor that contributed to our decision to discontinue the MS Teams spaces in 2023, contributing to simplifying the tool landscape from the learner perspective. As noted among the discussion of the corresponding design principle DP3-1, we also made the conscious effort early on to solely rely on digital environments provided and supported by our university for these channels. This design feature covers the non CEM-related infrastructure and thus applies to potentially all HyFlex courses.

***DF3-2**: Cloud-based modelling tools (if possible): Camunda, Stratamap*

Each of our two CEM course types had its own designated modelling tool (Camunda for BPMN and Stratamap – and later Archi once Stratamap was discontinued – for ArchiMate modelling). When choosing these modelling tools, we paid attention to the requirements of being freely available, platform-independent, conducive to collaborative modelling, and conformant to industry standards (e.g. BPMN or ArchiMate). In addition, students often chose other collaborative tools such as GoogleDocs, or LucidChart for their group-based assignment work outside of formal CEM tasks. This design feature therefore is the CEM-specific counterpart to DF3-1 about the necessary digital infrastructure for the courses.

***DF3-3**: Create videos covering the basic content without references to dates, course IDs or other course-specific arrangements*

In terms of course preparation, we made sure that most videos that we created were reusable for future course offerings. Thanks to the modelling languages and principles being relatively stable, we see no real need to record new videos each year. We achieved this goal by removing all visible and audible references to dates, recent events, course IDs (to allow re-use across programmes where appropriate), or matters of course organisation from the content videos. Course-specific provisions were catered to through separate videos, if necessary.

Such an arrangement can shift the course preparation emphasis in the future to selected additions, improvements, and removal of content or assignment arrangements. Any addition, improvement, or removal of content essentially means just to re-record a short video (or even parts of it, if video editing can do the trick) and thus will mean little additional effort besides the underlying research and the slide or guide document revisions themselves. This again is a design feature that applies beyond just CEM courses.

***DF3-4**: Create similar assignment structures and share cases between courses*

The previous feature of preparing videos for future re-use can also apply to attempts at re-using assignment structures and cases between courses. For instance, past offerings of the postgraduate level BP course had actual industry clients as case organisation for the large assignments, and an edited form of one of those cases was the foundation of the assignment cases for some the postgraduate and undergraduate level course instances of Table 2.

Along similar lines, some frequent shortcomings in the students' assignment submissions in the earlier BP course led not only to a revision of the corresponding assignment briefing document in order to improve clarity in the future but also to similar revisions in comparable assignment documents in both subsequent courses.

We also could share the same case for the simple exercises between all CEM courses covered in this paper. This case was not provided in written form but in short animated and narrated video vignettes which resemble a set of interviews with the stakeholders of a fictional organisation. Here, both courses can now benefit from the extra work of providing a video-based case (which already existed since the mid-2010s), and issues about this case noted in one course could then again be dealt with for all future course offerings relying on that case.

6 Course Architecture Evaluation

In this section, we first evaluate the overall course architecture based on the effectiveness and the students' reported appreciation of the courses instantiating the course architecture's design principles and features as shown in Figure 1. Afterwards we evaluate and reflect on the fitness-for-purpose and also the projectability into other contexts of the design features and principles.

Note that since every instance of a taught course is 'more than the sum of its parts' – including but not limited to the design principles and features that comprise the course architecture – we can only attribute a part of any success or failure to the underlying course architecture and its elements (Lukyanenko & Parsons, 2020).

6.1 Evaluating the Overall Course Architecture

We first evaluate our overall course architecture based on the effectiveness of each course and the extent the students appreciated it. To assess our course architecture's *effectiveness* in objective terms, we first provide the pass rates and median grades for all courses in Table 3.

Course Code	Year	Topic	Pass rate	Median letter grade
INFO 234	2021	Business process modelling	81.15%	B
	2022		80.35%	B
MBUA 511	2020		92%	A-
	2021		100%	A-
	2023		96.92%	A-
	2024		100%	B+
INFO 376	2021	Enterprise architecture modelling	94.3%	B+
	2023		94.2%	B
MBUA 514	2021a		100%	A-
	2021b		100%	A
	2022		100%	A-
	2023		98.41%	A-
	2024		100%	A

Table 3. Course pass rates and median letter grades

Note that there were only comparably minor changes of course content and assignments between offerings of the same course over the years, just with differing assignment cases or industry partners. Hence, we believe that comparing the outcomes across the courses can be done with a certain level of validity, despite the student cohorts and other factors changing between trimesters and years. Note further that we do not, however, compare the grade distributions among the offerings or to previous ones, due to the continuously changing circumstances for students during the pandemic in the timeframe.

Overall, the pass rates and median letter grades are on an at least respectable level on absolute terms, and in relative terms at least similar to other undergraduate and graduate courses held in the same time frame in the same programme. While lacking objective measures across courses and programmes, we believe the level of difficulty for these courses to be on the higher side, with INFO 234 and MBUA 511 comprising the whole cycle of process modelling, analysis and improvement (and in-depth assignments for each), and MBUA 514 having comprehensive architecture projects for real-life clients. Client feedback from actual enterprise architects involved in some of these projects indicates a high-level of comprehensiveness, quality, and relevance of the main assignment deliverables. Another at least partially useful proxy for course difficulty is the reported student workload which, according to Table 4, tends to be on the higher side for most offerings. A contributing factor to the high MBUA course pass rates is the usually very high motivation of the MBUA students who all come from different non-business analyst careers and enrol in the programme out of a clear motivation to transition into business analysis roles. A further notable – if anecdotal – objective indication for the effectiveness on the HyFlex side of our course designs is that the best student by quite a margin in INFO 376 in 2021 was a student who never attended a lecture or a workshop session in person but instead worked solely with the provided videos and sought feedback through e-mail and Zoom.

Subjectively, based on written student feedback about the course designs in the university-administered course evaluation surveys, there were two key factors contributing to their performance. First, they found the recorded content (DF1-3) to be at a good pace for learning. They also found it helpful that they were able to re-watch it as many times as required (in-line with DP1-3 and the HyFlex value of *reusability*). Second, the students also appreciated the weekly exercises (DF1-1), where they could ask questions, get feedback, and then apply the gained proficiency to their larger assignment project afterwards. In-line with DP1-1 and DP1-2 and the tenets of the IC/4D model for complex learning, these exercises required the students to learn how to apply what was being taught right away as opposed to just watching videos and then later panicking as assignment due dates came up. From the lecturers' point of view, there were a considerable number of students in each cohort who truly mastered the complex tasks of BP or EA modelling, and thus we view the assigned final letter grades as very much warranted.

Students also showed their *appreciation* for the course designs based on the course architecture in their evaluations as shown in Table 4.

Course Code	Year	Overall evaluation	Assess-ments help learning	Receiving feedback on progress	Video resources helped learn	Able to engage online well	Course workload[4]
INFO 234	2021	2.2	1.7	2.0	1.9	2.1	2.9
	2022	2.3	1.9	1.9	1.4	1.8	2.0
MBUA 511	2020	1.7	1.7	1.9	1.5	1.5	2.9
	2021	1.3	1.3	1.5	1.5	1.8	2.8
	2023	2.6	1.8	1.8	1.9	2.1	2.1
	2024	1.8	1.4	1.4	1.4	1.6	2.6
INFO 376	2023	2.7	1.8	1.9	1.9	2.4	2.3
MBUA 514	2021a	2.2	1.4	1.1	1.7	2.1	2.8
	2021b	1.8	1.7	1.8	1.8	2.3	2.1
	2022	1.4	1.4	1.6	1.4	1.4	2.0
	2023	2.3	1.6	1.5	1.8	1.6	2.3
	2024	1.5	1.4	1.4	1.2	1.4	1.9

Table 4. Key course evaluation results (scale 1-5; lower is better, except for workload, see footnote).

As with our course designs as noted above, the course evaluation surveys as administered by the university also remained unchanged between years. Note that the INFO 376 evaluations for 2021 are not included since less than 10% of the enrolled students answered that survey. Response rates for the other courses range between 15% and 65%.

[4] Note that the 'Course workload' column has a different scale compared to the other columns: 3=about right; higher values indicate higher than average and lower values lower than average course workload

The numbers in Table 4 show the students' general appreciation of several key aspects as well as the overall course offerings which are largely corroborated by the students' anonymous written course evaluation feedback, In particular, it was our impression that the students spoke largely favourably of

- The group-based weekly modelling tasks ('Assessments help learning', cf. DF1-1 and DF1-4) to keep them engaged in learning the content through regular opportunities for practice.
- The weekly feedback sessions on those modelling tasks ('Receiving feedback on progress', cf. DF2-1 to DF2-3) to break down a 2-hour session (for the undergraduate offerings) into smaller chunks and (for all offerings) to get relatively quick feedback.
- The usefulness of the introductory content provision in video form ('Video resources helped learn', cf. DF1-3) to easily learn the topics through the weekly exercises.
- The availability of a variety of channels for engagement ('Able to engage well online', DF2-3 and DF3-1) to have the flexibility and also to feel comfortable to learn in-person or online.
- The overall effectiveness of the course designs in terms of structure, regular progress and reflection opportunities, and the assignments being related to the students' future careers.

There is, however, the exception of the overall evaluation 'outlier' for INFO 376 in 2023. Here, the underlying reasons for the rather low score are difficult to ascertain, as the other scores and comments of the entire course and teaching evaluation (so not just the values shown) and the lecturer's personal impression point towards an overall quite appreciated course. In 2023, MBUA 511 and 514 were offered at the same time to the same cohorts which – thanks to the very similar topic and format – was not conducive to focused student learning for BPM and EA at the same time and may have contributed to also a rather low overall score. For 2024 and beyond, these two courses were offered in subsequent trimesters, contributing to much improved scores for 2024.

In sum, the quantitative and the qualitative data for all the courses that were based on the course architecture outlined in this paper show that the individual courses were both effective in the students attaining the complex skill of CEM while simultaneously being generally appreciated by the enrolled students with a few exceptions as discussed above. Since our course architecture is an abstraction over these individual course instances, we therefore claim a high level of fitness-for-purpose for the course architecture as well.

6.2 Evaluating the Design Principles and Features

To unpack our comprehensive course architecture further, we now evaluate each of our design principles and features with respect to their *fitness-for-purpose* (or utility) as well as their *projectability* into other contexts, as recommended by vom Brocke et al. (2020) for design science-related knowledge contributions. Specifically, since the design features are closest to the actual artefacts (course offerings), the main evaluation focus here is their fitness-for-purpose to meet the design requirements, whereas we additionally reflect on projectability for the more abstract design principles. We further reflect on the researchers' *personal confidence* (so not any statistical confidence) in our evaluations and contributions further down in the Discussion.

6.2.1 Evaluating the Learning Outcome-related Design Principles and Features

The main design requirement to fulfil with respect to learning outcomes is to focus on the students' proficiency in the complex skill of conceptual modelling and corresponding reflective capability. Table 5 shows the evaluation of the corresponding design features.

Design Feature	Relation	Fitness-for-purpose evaluation
DF1-1: Weekly modelling exercise & reflection assignments	DP1-1, DP1-2	Having weekly assignments proved effective for fostering continuous student engagement with learning tasks aimed at developing small-scale guided CEM proficiency, reflection, and feedback opportunities.
DF1-2: Large case-based modelling assignments	DP1-1	Having a large case-based assignment proved effective for assessing large-scale and autonomous student proficiency in the complex skill that is CEM.
DF1-3: Weekly introductory content videos	DP1-3	A weekly set of content videos on modelling foundations proved to be adequate in terms of supporting information to equip the students with the necessary knowledge to tackle the weekly assignments and, subsequently, the large case-based assignment.
DF1-4: Group-based weekly small-scale modelling exercise tasks	DP1-1, DP1-2, DP2-1a, DP2-1b	Organising small groups for the weekly exercise assignments proved effective for giving the course additional structure, continuous student engagement and ultimately developing the students' modelling proficiency. In addition, these weekly exercises proved useful as a backdrop for the students to reflect upon. Having to mark weekly assignments goes somewhat against DR3-2 but is worth the effort from the authors' perspective (which is supported by student feedback). In addition, this is a marking task that can be (and was, in our cases) taken care of by tutors.

Table 5. Evaluating learning outcome-related design features of our HyFlex course architecture

Design Principle	Relation	Fitness-for-purpose and projectability evaluation
DP1-1: Structure the course around small and large-scale practical modelling and reflection assignments	DF1-1 DF1-4	As the corresponding design features were evaluated as fit-for-purpose, we likewise see these design principles to be fit-for-purpose for a HyFlex CEM course design to attain modelling proficiency. In terms of projectability into other contexts, we regard the principle of scaffolding assignments with increasing complexity as applicable to potentially many other courses beyond CEM and also beyond HyFlex contexts. The nature of these assignments would have to be tailored to other course learning objectives and content, however.
DP1-2: Provide incentives for continuous engagement with the modelling assignments	DF1-1 DF1-4	As with the previous design principle, we see incentives for continuous engagement with assignment not only as an effective design principle for our specific context, but also as one that can be projected into many other contexts beyond CEM and HyFlex, as it reduces the chance that students will leave starting their learning efforts too late.
DP1-3: Provide means for asynchronous content provision of CEM foundations	DF1-3	We see the asynchronous content provision of course foundations as fit-for-purpose for CEM and also many other contexts where the focus lies on attaining practical proficiencies. And while not the only means of providing content in a HyFlex environment, we would regard it as particularly challenging to solely rely on synchronous content provision in such an environment. Outside of HyFlex, there is, however, a good argument to be made for the 'personal touch' in a classroom instead of just having videos with, at best, a 'talking head'.

Table 6. Evaluating learning outcome-related design principles of our HyFlex course architecture

Overall, these four design features proved to be useful characteristics of our HyFlex course offerings to attain conceptual modelling proficiency and corresponding reflective capability. In Table 6, we now evaluate our learning outcome-related design principles in terms of fitness-for-purpose as well as projectability into other contexts beyond CEM and HyFlex.

In sum, while all three design principles are indeed fit-for-purpose like the design features, there are more nuanced concerns around their projectability into other contexts outside of CEM and HyFlex.

6.2.2 Evaluating the Communication-related Design Principles and Features

The second of our three areas in Figure 1 revolves around the requirements of communication between students across engagement modes (optional in our context) and between students and lecturers (non-optional) across engagement modes, as well as having the option for both to be able to freely shift their engagement modes. Table 7 covers our evaluation of the corresponding design features with respect to their fitness-for-purpose.

Design Feature	Relation	Fitness-for-purpose evaluation
DF2-1: Weekly sessions for review of weekly exercise tasks	DP2-2a, DP2-2b	Having a weekly synchronous session (in whichever form) proved to be an effective forum for questions and feedback to draft versions of the weekly exercise deliverables.
DF2-2: Participation in all sessions can be in-person or via Zoom	DP2-2a, DP2-2b	Having at least one weekly synchronous session was effective in answering questions and giving feedback regardless of engagement mode. Even if the lecture Zoom sessions only had a few attendees at most (see above), they usually still had a few questions that could be answered through the Zoom chat.
DF2-3: Alternative feedback through e-mail / Canvas messages / MS Teams chats	DP2-2a, DP2-2b	Having a complementary asynchronous alternative channel for questions and feedback was at least sporadically used by students and thus proved to be an effective complementary channel. The uptake varied between courses and cohorts, however, but the circumstances in each context were too different to analyse the impact of participation in this channel further.

Table 7. Evaluating communication-related design features of our HyFlex course architecture

Design Principle	Relation	Fitness-for-purpose and projectability evaluation
DP2-1a: Provide means for synchronous and asynchronous interactions between students	DF1-4 DF1-4	Having multiple options – both dependent and independent of time and space – for student interaction proved effective to support the students' group work efforts for the weekly exercises as well as – if applicable – the large-scale assignments later in the course in the light of varying circumstances over the years. More generally speaking, having these options seems to be a necessity for a HyFlex course design in any context – again, in case the course depends on (or at least benefits from) mutual student interaction. We further believe that even regular in-person courses relying on student interaction can benefit from having multiple communication channels available, even if they are only complementary.
DP2-1b: Provide means for in-person, virtual and hybrid interactions between students		
DP2-2a: Provide means for scalable synchronous and asynchronous student / lecturer interactions	DF2-1 DF2-2 DF2-3	Similar to DP2-1a and DP2-1b, having multiple possibilities of interactions between students and teaching staff proved effective (and essential) to support the students attaining the intended learning outcomes. As with the previous two DPs, we regard such arrangements (in whichever form) to be essential for HyFlex courses of any form in any context, and at least nice-to-have even for non-HyFlex courses.
DP2-2b: Provide means for in-person, virtual and hybrid student / lecturer interactions		

Table 8. Evaluating communication-related design principles of our HyFlex course architecture

Based on these mostly positive evaluations of the design features in terms of their fitness-for-purpose, we now assess the more abstract design principles in terms of their fitness-for-purpose for our context, and also with respect to their projectability into other contexts in Table 8.

In contrast to the design principles in the previous area, we find the principles here to be projectable to basically any HyFlex context, or even to teaching contexts outside of HyFlex.

6.2.3 Evaluating the Resource-related Design Principles and Features

The requirements for this area revolve around keeping the technical barriers for students low and the lecturers' efforts for course preparation and operation manageable. Table 9 shows the evaluation of our four design features for this area regarding their fitness-for-purpose to meet the requirements.

Design Feature	Relation	Fitness-for-purpose evaluation
DF3-1: Infrastructure: Blackboard / Canvas, Zoom, Panopto, Office 365, MS Teams	DP1-3, DP2-1a, DP2-1b, DP2-2a, DP2-2b, DP3-1, DP3-2	While this set of digital tools does not the simplest of landscapes make, all these tools are university-provided, proved effective and were well-integrated so that little administrative overhead was necessary. The students were also already used to these tools from their previous courses, so they did not turn out to be a barrier for engagement.
DF3-2: Cloud-based modelling tools (if possible): Camunda, Stratamap	DP2-1a, DP2-1b, DP2-2a, DP3-1, DP3-2	Cloud-based, free, and proven industry-standard platforms for CEM proved to be effective for fostering student collaboration as well as easy lecturer feedback (e.g. by sharing and commenting on the models in the cloud). In addition, having to switch to a non-collaborative EA modelling tool (Archi) for the most recent EA course iterations highlighted the benefits of these functionalities for student collaboration. Using those tools can also be seen to be a part of student modelling proficiency.
DF3-3: Create videos covering the basic content without references to dates, course IDs or other course-specific arrangements	DP3-3	Paying special attention to the reusability of shared content between course offerings and courses allowed easy re-usability. In addition, all courses can thus benefit automatically from any improvements to the shared content material. Course-specific arrangements can be addressed in course-specific videos.
DF3-4: Create similar assignment structures and share cases between courses	DP3-3	Reusing the basic assignment structure as well as the assignments themselves between course offerings and courses has similar advantages to DF3-3.

Table 9. Evaluating resource-related design features of our HyFlex course architecture

Again, all design features proved fit-for-purpose and contributed to the overall course architecture effectiveness. As in the previous two sections, we now assess our design principles with respect to their fitness-for-purpose as well as their projectability into contexts beyond CEM and HyFlex in Table 10.

As with the design principles in the previous area, we see a high extent of projectability of these design principles into non-CEM and also even into non-HyFlex contexts.

Design Principle	Relation	Fitness-for-purpose and projectability evaluation
DP3-1: Rely on familiar and/or simple digital tools as much as possible	DF3-1 DF3-2	This principle was insofar effective that we did not have answer much, if any, support queries from the students regarding the basic tool infrastructure. Instead, we could focus on teaching the use of the CEM tools which were part of the course learning objectives. In our view, this principle becomes even more crucial in other contexts outside CEM and Information Systems, especially since CEM courses are technical courses by nature and students in all our programmes were expected to have at least a moderate level of digital literacy. It also is highly relevant for all sorts of HyFlex contexts since HyFlex courses often rely on a set of digital tools to implement the varying engagement modes.
DP3-2: Limit the use of non-supported and non-integrated digital tools	DF3-1 DF3-2	As with the previous principle, we appreciated that any support queries regarding for all tools except the modelling tools could be taken on by the university’s digital helpdesk, and we see this being applicable for all types of courses beyond CEM and HyFlex.
DP3-3: Focus on re-usability of content across course offerings	DF3-3 DF3-4	Given the – at least for the first offering – quite substantial transformation effort of designing or redesigning a HyFlex course offering, we regard this principle as crucial for sustained feasibility of HyFlex course offerings, as we found subsequent offerings not substantially more resource or maintenance intensive than traditional non-HyFlex offerings. We also came to appreciate a good amount of flexibility and scalability in our HyFlex course designs when having to adjust to changing circumstances such as substantially increased student numbers.

Table 10. Evaluating resource-related design principles of our HyFlex course architecture

7 Discussion and Limitations

As our contribution comprises prescriptive knowledge (or knowledge for design and action), we thus now evaluate our overall contributions against the three criteria proposed by vom Brocke et al. (2020) for this type of knowledge: *fitness-for-purpose*, *projectability*, and the researchers’ *personal confidence* with which they make these claims. As we are not striving for truth or accuracy (as one would for theoretical contributions to better understand the real world), other common contribution evaluation criteria such as generalizability do not apply.

The assessment of each design principle and feature in Tables 5-10, as well as the supporting data with respect to course effectiveness and the appreciation by the students (Tables 3 and 4), illustrate that the overall course architecture of Figure 1 as an abstraction over the individual course offerings (artefacts) indeed turned out to be *fit-for-purpose*. Each design feature has proven effective in the courses where they were instantiated and contributed to the overall course architecture effectiveness. The average quality of student work as well as the grades and pass rates across all courses also indicate that the courses indeed managed to reach the learning objectives. The results further indicate the positive impact of the HyFlex aspects of the course design since several courses had substantial parts of the student population unable to attend any in-person sessions. Simultaneously, many of the students enrolled in the undergraduate courses chose to attend the weekly two-hour in-person session (pandemic alert levels permitting) despite videos with the same content being available each week as an alternative offering. The course evaluation results likewise indicate that the students by and large appreciate the flexibility of the HyFlex course designs. Moreover, by relying on graded small-scale weekly modelling exercises we managed to overcome the potential issue of student procrastination that Bogdanova and Snoeck (2018) indicated (as mentioned in section 2.4).

We further found our course architecture to offer *additional flexibility* not just from the learners' but also from a course design perspective, allowing us to adapt our courses rather easily to changing circumstances. The best example here concerns the scaling of the courses to different student numbers over time (e.g., from around 20 in 2021 and 2022 to over 60 in 2023, cf. Table 2) where essentially the offerings merely needed different scheduling and room arrangements for the synchronous parts (cf. section 5.2.3) and all other course components could largely remain as they were. For regular non-HyFlex course offerings, we would have expected a much higher difficulty in meeting the scaling-up challenge without a complete duplication of efforts. We therefore posit that a HyFlex-oriented course redesign offers an opportunity to break up a traditional 'course monolith', allowing additional future flexibility from a course design perspective as well.

In terms of *projectability* into contexts beyond CEM and HyFlex, the evaluation of the more abstract design principles in Tables 6, 8 and 10 shows that especially the communication-related design principles are potentially projectable into contexts far outside the narrow scope of CEM and HyFlex while other design principles are more dependent on the specific circumstances (course learning objectives, course content, assignment types, extent of HyFlex considerations etc.). Unpacking the parts of our admittedly extensive course architecture into ten design principles across three areas thus allows other educators to 'pick and choose' design principles to instantiate into their own varying contexts to address specific concerns.

On a more abstract and methodological level, we see our treatment of course offerings as design artefacts that merely provide a backdrop for design theorising in the form of unpacking these artefacts into design principles and features that fulfil underlying design requirements as a potential general blueprint to codify design knowledge in the higher education course design context within and beyond the IS discipline.

With respect to the evolution of our CEM teaching approach and related teaching practices, here it was the specific circumstances of the global pandemic of the early 2020 that provided the trigger for us to pursue that path over several years and iterations. On reflection, we cannot help but posit the question what other less widely disruptive triggers could there be under more normal circumstances for a push to evolve one's teaching practices beyond established boundaries and routines? In order to make the leap from knowledge for design (as the majority of the paper has focused on) to action in the best spirit of impactful design science research at this point, Table 11 raises a couple of questions that other educators can use as triggers to start interrogating and advancing their own teaching practices based on this paper's contributions, and outside of 'global crises'. The projectability angles are taken from the reflections in Tables 6, 8, and 10.

Since our experiences are limited to a single university and faculty context, the overall *personal confidence* with which we present our findings cannot be overly high. Moreover, any redesign, application, and evaluation of our course architecture has happened between the two authors of this paper and thus carries a certain amount of subjectivity. Furthermore, the context around the courses (programme, faculty, university infrastructure, country, situation in the country) has been – pandemic notwithstanding – reasonably stable over the time the HyFlex offerings were made. Any projection of our design requirements, features, and principles into contexts that vary quite substantially with regards to one or more of those factors may yield entirely different results, however.

Projectability angle	Call to action
Other CEM courses	How can the provided course architecture help to inspire changes in existing CEM courses / modules (even if these courses are offered in a predominantly in-person and/or synchronous way)?
Other courses that offer in-person / remote options and/or have synchronous and asynchronous elements	How can the provided design principles and features inform how courses with HyFlex facets are being offered in order to enhance aspects such as flexibility or accessibility from a student viewpoint?
Other IS courses	How can the course architecture as a whole or specific design principles and features be adapted and applied outside the context of this paper's courses to review other IS courses with respect to their fitness-for-purpose and provide inspirations for their improvement?

Table 11. Three calls to action for other IS educators

Simultaneously, we have now offered several courses across two programmes and topics over several years based on the same overall course architecture and found the resulting formats to be generally effective and appreciated (with a number of caveats based on specific or changed circumstances, cf. section 6.1). Based on our own personal confidence in the course architecture, we plan to continue and refine our current course designs for future offerings and even consider expanding it into neighbouring topics such as application development, business analysis, or information security. Here, especially the first set of design features or even principles might need some more substantial redesigns for topics that are less 'hands-on' and do not have discrete deliverables – such as BP or EA diagrams – as outputs that lend themselves well for weekly exercise assignments.

A further limitation for our findings is the limited set of measures (such as pass rates in Table 3 and student survey outcomes in Table 4) that we can apply to our courses without having set up a specific study design including more tailored measurements in advance. Along similar lines, we are limited to assess effectiveness and appreciation for instances of our course and can only infer from these instances to the more abstract design features and even more abstract design principles of the course architecture (Lukyanenko & Parsons, 2020). Moreover, some design principles or features, in isolation, may appear close to common sense, but we believe that their placement and role in the course architecture as a whole makes the course architecture fit-for-purpose and re-usable / projectable in the end. As Figure 1 and the subsequent descriptions show, there are many connections between the DRs, DPs, and DFs within and even across the three general areas of the course architecture.

Moreover, these levels of abstraction of the course architecture may also not only be a strength of our contribution (in the sense of fostering re-usability or projections into other contexts) but also a weakness. The course architecture does not cover the specific artefacts (such as the course outline, the style and length of the videos, or the assessment design and corresponding briefs) that comprise our course instances. Hence, there is a certain limit to the re-usability of the architecture for the design of other CEM courses. Therefore, the results for other educators adopting our course architecture to their own courses and context may vary because of these small but important nuances.

In the absence of an online repertoire, however, the authors are willing to share their specific materials such as teaching plans or assignment briefs upon request. Our course architecture thus gives (or rather, forces upon) any future user a certain degree of freedom for their own designs and adaptations.

8 Conclusion and Outlook

In this paper, we developed six design requirements, ten design principles and eleven design features for HyFlex CEM courses. These requirements, principles, and features are based on and evaluated against the authors' experiences in teaching several CEM courses with two topics (BP and EA modelling) across two IS programmes. We thus contribute a holistic yet generalised course architecture for teaching CEM in a hybrid (in-person and online offerings) and flexible (synchronous / asynchronous participation) way.

Our design principles and features as well as the reported specifics of our course designs allow other instructors in the CEM field (and potentially other fields, particularly related to the DP and DF of the 2-x / 3-x areas) to take inspiration to develop their own – and hopefully at least equally effective and appreciated – variants for their contexts, as appropriate (see also Table 11). Particularly the projection of our design principles and features into non-CEM contexts or a more focused analysis how such a format can enhance non-mainstream student experiences – e.g., for students with special accessibility needs – are areas we see as promising for future research.

There is also room for further research to further investigating whether HyFlex course designs indeed lend themselves well to scaling, or whether it was just down to our specific context and the arrangements we made. Notably, the only of our three course design areas that was substantially affected by scaling was the communication part, i.e. the design feature around scheduling the synchronous sessions. This is one indication that HyFlex courses indeed may lend themselves quite well to scaling, unless a high amount of synchronous sessions are needed, with corresponding implications for staff, rooms, and other resources. We see a major reason for this in the 'decoupling' of learning from time and space in the resulting course designs, so that alterations to one facet (in this case, mainly (physical) space) has comparably little bearing on the overall course design and elements as well as the effectiveness of learning. However, we can only make this inference for one specific type of course (CEM courses in-line with our provided course architecture), so this also warrants further research attention.

Beyond our course architecture, we regard a further – more theoretical – exploration of complex learning and the IC/4D model (as introduced in section 2.2) in the IS educational context to be a worthwhile endeavour for future pedagogical IS research.

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