Navigating multilevel challenges in learning design: an investigation of novice designer teams' learning trajectory

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Abstract: Learning Design (LD) is a complex activity involving design decisions at multiple levels, from overall course objectives and pedagogical approach to task sequences, tasks and resources. Traditionally, the higher-level design decisions from the course to task levels are made by teachers, whereas instructional designers are engaged mostly in distance/online learning contexts for the detail design of tasks and resources. This paper reports on a study of novice Learning Designers (LDers) taking a master's level LD course underpinned by a 7-step model of LD spanning from the specification of course level outcomes to the design of learning tasks, resources, Learning Analytics (LA) and feedback. Students' LD was supported by a technology platform, the Learning Design Studio (LDS). The findings reveal the challenges encountered by course participants. Further, the conceptual and technological LD tools used in the course fostered the articulation of pedagogical reasoning and helped to reveal incoherence and misalignment in the designs.

Keywords: learning design; novice designer teams; Learning Design Studio; constructive alignment; Bloom's taxonomy; learning design triangle; learning design tools; learning designers.

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1 Introduction

Learning Design (LD) is an emerging field (Law et al., 2017) involving practitioners from the teaching and teacher education professions as well as Learning Designers (LDers) and technologists connected with the broad field of instructional design. The former are often concerned with design starting from the course level, making design decisions on learning outcomes, task sequences, assessment, etc. The latter focuses on the development of tools and resources to support learning (Conole, 2013). With the increasing prevalence and accessibility of digital tools and online resources, many teachers who do not have the luxury of engaging the support of educational technology specialists in their course design work are able to integrate their use in teaching and learning (Charlton et al., 2012). This does not only blur the distinction between LD and instructional design, but also creates a need for LD professional development to include the full range of LD activities from course level down to the level of individual learning resources.

While the creation of LD as design artefacts are tangible outputs from the LD process, teachers, teacher educators and educational researchers often perceive the focal purpose of LD as a form of teacher learning in which the productive, creative aspect of the activity constitutes the core attractiveness of LD as an effective means to foster transformations in teachers' pedagogical practices (Mor, et al., 2015b).

During the design process, the LDers should ideally make the connection between the intended learning outcomes, theoretically grounded design principles, and the detail design of learning tasks and resources for implementation (Conole et al., 2004; Persico and Pozzi, 2015). However, empirical studies in the literature have shown that deep explorations of pedagogical rationales behind LD solutions is rare among novice LDers

(e.g., Ertmer et al., 2013; Rowland, 1992). There are several key challenges encountered by novice LDers. First, there is a strong tendency to be content focused (i.e., on the design of tasks and resources) rather than attending to the pedagogical rationale underpinning the LD (Conole and Wills, 2013). A related challenge is the lack of coherence between novice LDers' designed curriculum units and the pedagogical theories they were supposed to adopt (Flores et al., 2014). Nguyen and Bower (2018) found in a study involving pre-service teachers in a well-structured five-week program that emphasised pedagogical considerations in the design process from the course level topics to activities through to aesthetic design, pedagogical concerns were rarely mentioned during the collaborative design activities by the student teachers. Efforts to scaffold the LD process using technology-based LD tools have been reported in the literature. Pozzi et al. (2020) reported on a two-day intensive training course for LDers from K-12 schools using the LD tool Pedagogical Planner (PP). Even though PP defined clear design phases for the LDers to follow, the course participants tended to jump from one phase to another or skip some steps during the design process. as pointed out by Conole et al. (2004), there is a need for models that can provide appropriate mappings between pedagogical approaches, processes, tools, and techniques to provide more effective guidance to novice LDers in the design process to ensure alignment between learning outcomes, pedagogy and the designed learning tasks and resources. Moreover, the availability of appropriate frameworks and visual representational tools could be valuable in providing a stronger pedagogical focus to the design process (Conole and Wills, 2013).

In this study, we pilot a design for a Master level course on e-learning design that provides a conceptual tool, the Learning Design Triangle (LDT, Law and Liang, 2020) and a technology platform, the Learning Design Studio (LDS, Law et al., 2017) to scaffold novice LDers' in their design process. Two specific research questions are addressed:

RQ1: What are the most prominent difficulties encountered by the course participants from the start to the completion of the course design work required in the course?

RQ2: Whether and how the novice LDers' conceptions about various aspects of the LD process changed during their course of study?

2 Background

In this section, we review literature on these key challenges encountered by novice LDers as well as conceptual and technological tools that have been developed to scaffold the LD process. We begin by reviewing in the Sub-section 2.1 the lack of awareness of and strategies for alignment across outcomes, activities, and assessment; a tendency to focus on curriculum content rather than pedagogically-inspired, learning-focused LD and inadequate understanding of the hierarchically nested levels of pedagogical decision-making in LD. Sub-section 2.2 reviews the conceptual and technological tools for scaffolding the learning design process reported in the literature.

2.1 Challenges to the development of pedagogically sound LD

2.1.1 Lack of awareness of and strategies for alignment across outcomes, activities, and assessment

The first challenge concerns the difficulties in achieving a coherent and aligned design across outcomes, activities, and assessment. In a study of novice teachers' design process in developing an e-learning LD on Moodle in groups in the context of a 4-week training course, Boloudakis et al. (2018) reported clear improvements in the clarity and completeness in the students' design of elements such as learning activities and resources. However, none of the groups improved in the alignment between intended learning outcomes and designed activities, and there is little evidence in the incorporation of collaborative, active learning in their designs. In another study on a design course for graduate students that integrated theoretical and practical aspects of educational technology, Ronen-Fuhrmann and Kali (2015) found that while the novice designers may be able to write statements of outcomes for targeted learners, their design activity focused on the hierarchy of the content knowledge rather than on learners' experience in understanding what to do and how to navigate in the learning environment to achieve the intended outcomes. Ertmer et al. (2013) observed that among the factors needed to be aligned in learning design, assessment is the most misaligned factor as traditional assessment design tends to encourage surface learning rather than promoting student-centred learning approaches that are conducive to fostering 21st century learning outcomes.

2.1.2 Content-focused rather than pedagogically-inspired, learning-focused LD

Another challenge relates to designers' tendency to focus on content rather than pedagogy. Nguyen and Bower (2018) reported on their study of three groups of pre-service teachers who participated in a five-week collaborative project to design technology-enhanced LDs. They found that despite the teacher education program's emphasis on pedagogy, the pre-service teachers rarely considered or mentioned pedagogical concerns during their design activities. The qualitative research on teachers' views about LD approaches by Postareff and Lindblom-Ylänne (2008) revealed that novice teachers' primary attention was on dealing with the practicalities of their performance as a teacher in the classroom. They tended to be content-focused, spending much of their design efforts on the development of detailed course plans and the associated course schedules and content materials. This content focus hinders their ability to design authentic learning tasks and context that foster students' ability to learn new skills and construct knowledge, which requires that they take on a learning-focused approach in their design practice. Bennett et al. (2016) found that teachers' adoption of content- or learning-focused LD was context dependent. Teachers are more likely to adopt learning-centred approaches if they are familiar with and confident about the content, and if relevant learning resources are readily available.

2.1.3 Inadequate understanding of the hierarchically nested layers of pedagogical decision-making

The third challenge pertains to the inadequacy of conceptions and applications of pedagogies. There could be different reasons for the inadequate articulation of the

pedagogical considerations underpinning LD decisions as reported in the literature. One such reason is the lack of awareness that there are different layers of hierarchically nested pedagogical foci. Der-Thanq et al. (2007) reported instances of in-service teachers' misappropriating pedagogical concepts, reflecting their misconceptions about the fundamental tenets or epistemologies of these constructs. Teachers who declare their epistemological commitment as constructivist and/or social constructivist may be content-based in their pedagogical practice and yet unaware of their misinterpretations. In his investigations of challenges encountered by teachers in their learning and appropriation of pedagogical constructs, Bower (2017) identified the key challenge to be the pedagogical design complexities required of LDs that aim to achieve meaningful and authentic learning. This requires the LD to provide opportunities for learners to engage in ill-structured and complex learning tasks situated in the real-world contexts. To do so, educators need to draw on different pedagogies to scaffold students' inquiry as they progress through the emergent phases of the learning process, and to facilitate learners' reflection on their learning experience. This is in stark contrast to Bower's (ibid.) empirical finding that some teachers would prefer adopting one pedagogy for the overall learning design because they believe this to be more effective.

Bower's (ibid.) work points to the inadequate understanding about the complexities involved in the pedagogical decision-making process. The complexity lies in the fact that there needs to be pedagogical considerations in each layer of decision-making from designing the overall course structure to specific learning tasks and learning resources. Goodyear (2005) identified four layers of pedagogical decision-making. At the top is *pedagogical philosophy*, such as instructivism or constructivism, which refers to the LDer's beliefs about how people learn, the nature of knowledge, and the type of learning outcomes valued. While pedagogical philosophy has a pervasive influence on the design process, the influence is often implicit and is not associated with specific design decisions. The highest level of conscious, explicit design decisions is at the level of *pedagogical approaches*, e.g., problem-based learning, experiential learning, cognitive apprenticeship, etc. Pedagogical approaches are connected to their underpinning pedagogical philosophies through distinctive forms of learning experiences that are considered to be conducive to the achievement of the learning outcomes compatible with and valued by the pedagogical philosophy.

Each pedagogical approach has its own 'signature' sequence of major blocks of learning experiences, such as defining the problem and devising a plan for a solution in the case of problem-based learning. The design of each of these blocks should be guided by a compatible *pedagogical strategy*, which provide a broad sketch of the learning tasks for achieving the targeted learning objectives as appropriate for the particular block. For example, if the pedagogical approach adopted requires that students become aware of their intuitive conceptualisations in the topic to be studied, a suitable pedagogical strategy could be predict-observe-explain (Kearney, 2004). A pedagogical strategy generally comprises a sequence of tasks as exemplified in the predict-observe-explain strategy. There are also design considerations at the level of each learning task, which Goodyear (2005) refered to as *pedagogical tactics*, which may include the use of motivators such as badges, organisational techniques such as ways of grouping students, the provision of supporting learning resources such as the assessment rubric, etc.

2.1.4 The challenges are interconnected

The three key challenges reviewed above are in fact connected as it is generally agreed that LD should start with the specification of the learning outcomes that students are expected to achieve at the completion of the designed learning activities (Biggs, 1996; Spady, 1994). According to the outcome-based approach (Biggs, 2012), the LD comprising learning environments, activities, and resources should engage students with meaningful learning experiences that foster the intended learning outcomes. Assessment design is a core component of LD as it provides evidence on the extent to which the intended learning outcomes are achieved as well as the efficacy of the LD. An important quality indicator for an LD is whether there is 'constructive alignment' across the intended learning outcomes, the designed learning experiences, and the assessment (Biggs, 1996). As explained earlier, complex decision-making at each of the four hierarchically nested layers as described by Goodyear (2005) is involved in the LD process. Constructive alignment can only be achieved if the pedagogical principles underpinning the four levels of decisions are aligned and coherent. The tendency for novice LDers to focus on content rather than pedagogy is partly related to their inability to operationalise pedagogical concepts in the design process (Ronen-Fuhrmann and Kali, 2015). The 7-step model of LD piloted in this study provides a layered structure to guide LDers in the LD process that foregrounds the pedagogical considerations for each layer, and provides visualisations of the different layers of design to check alignment. This 7-step model is supported by a conceptual tool and a technology platform. In the next section, we review research on different conceptual and technical tools developed to scaffold the LD process.

2.2 Conceptual and technological tools to scaffold the learning design process

Designers, irrespective of their design discipline, need conceptual and technological tools to scaffold their design work both as an individual designer, and as a community of practice to communicate and share design ideas and artefacts. In this section, we provide a brief review of LD tools in the literature, with particular focus on those that are adopted in the current study.

2.2.1 A taxonomy of learning outcomes

The revised Bloom's Taxonomy is by far the most popular taxonomy currently adopted by LDers. It provides a common language that educators can use to describe behaviours that learners would be able to perform as an outcome of having engaged in the learning tasks. In particular, the provision of the sample lists of verbs in the revised taxonomy for each of the six levels of cognitive outcomes (remember, understand, apply, analyse, evaluate, create) directs the LDers' attention to the learners' behaviours rather than the contents to be taught (Conklin, 2005). The verbs also provide a guide for the kind of learning and assessment tasks that can be adopted in the LD process that are compatible with the intended learning outcomes.

2.2.2 A task taxonomy to highlight different categories of learner experiences

An important conceptual difference between learning design and instructional design is that the former should be focusing on the learners' experiences rather than what the

teacher or instructor does. Task taxonomies have been created to guide the LDers' attention towards the specification of the nature of the learner's engagement. One well-known taxonomy is the six learning types (Laurillard et al., 2018) – acquisition, collaboration, discussion, investigation, practice and production – developed according to Laurillard's (2002) conversational framework, with each learning type describing a cycle of interaction between the teacher and the learner or between the learner and peers. While the six learning types provide a strong focus on the nature of pedagogical interaction, it does not serve our purpose of describing unambiguously distinct types of learner activities for the specification of learning that also caters for the lower levels of pedagogical decision-making at the pedagogical strategy and tactics levels described in Sub-section 2.1.3.

Another taxonomy was a list of seven learning design activities (Rienties and Toetenel, 2016) – assimilation, finding and handling information, communication, productive, experiential, interactive/adaptive and assessment – developed in the Open University Learning Design Initiative (OULDI) (Cross et al., 2012). The first six of the activity types provide a broad description of the activities that can be designed to support learning, while the last one simply identifies the need to design activities for the purpose of assessment. Again, while this taxonomy provides a helpful framework for designers in thinking about different types of activities, it was not designed for the purpose of specifying exhaustively and unambiguously each and every task in a learning design.

In both of the taxonomies reviewed above, the categorisation attempts to cater for multiple aspects that needs to be considered in the process of task design: the epistemological orientation of the task (e.g., acquisition, practice, investigation, production), the nature of the task (e.g., finding and handling information), the social organisation of the task (e.g., collaboration), and the pedagogical function of the task (e.g., assessment). For the purpose of this study, we adopted a two-tiered task taxonomy (Law et al., 2017) comprising four task categories (directed, exploratory, productive and reflective learning), each category consisting of three different task types. The four categories specify the epistemological orientations of the learning tasks, which ranges from instructionist (directed learning) to cognitivist/ constructivist (exploratory learning), and constructionist approaches (productive learning). While LDers should have a clear epistemological commitment, their designs need to take account of how people learn, and that learning is an iterative process progressing from lower to higher levels of outcomes as described in the Bloom's Taxonomy (Anderson et al., 2001), which comprises six levels: remember, understand, apply, analyse, evaluate and create. Directed learning tasks could be valuable if remember and understand are the targeted outcomes. Exploratory tasks would be appropriate to achieve outcomes at apply, analyse and evaluate levels, while productive tasks would be suitable for outcomes targeted at the level of creation. Reflective learning tasks are necessary to promote metacognition, which is essential for fostering 21st century skills (Butler and Winne, 1995). Figure 1 presents the list of 12 learning task types grouped under the four categories of learning.

In addition to having a two-tiered structure that clearly differentiates the epistemological orientation and the specific task type, Law et al.'s (2017) task taxonomy also provides LDers with a fine-grained description of design decisions for each task, such as the social organisation for implementation and whether the task is used for the purpose of assessment. These design features at the task level are referred to as

task settings. Social organisation is an important task setting that must be defined. Each of the 12 task types can have four possible social organisation settings: individual, peer, group, or whole class. For example, a reading task can be designed to involve social interactions and discussions by using a collaborative annotation and shared reading platform such as Hypothesis (n.d.) or Perusall® (n.d.). Likewise, based on the notion of assessment as learning (Dann, 2014), LDers can indicate for each learning task whether it is included as an assessment task or not. In fact, Law et al.'s (2017) task taxonomy has a layered structure for the LDers to enter additional sub-task settings such as time allocation, the tools and resources needed for the task, allowing for more detailed design in the hierarchically nested layers of decision-making. This feature allows the LDers to clearly situate the fine-grained aspects of their design within higher levels of task and associated pedagogical context, and hopefully to remain pedagogically- and learning-focused, circumventing the challenges of being content-focused as described in Sub-section 2.1.2. Figure 2 provides a graphical layout for the subtask settings in the description of a learning task.

Figure 1 12 task types categorised under four broad learning experience categories (Law et al., 2017)

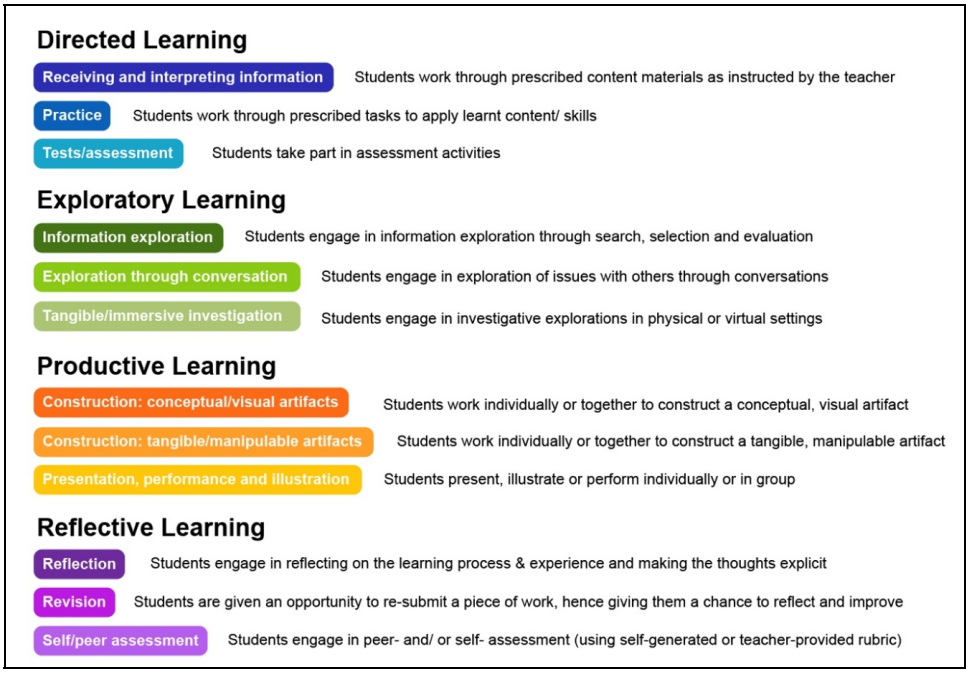
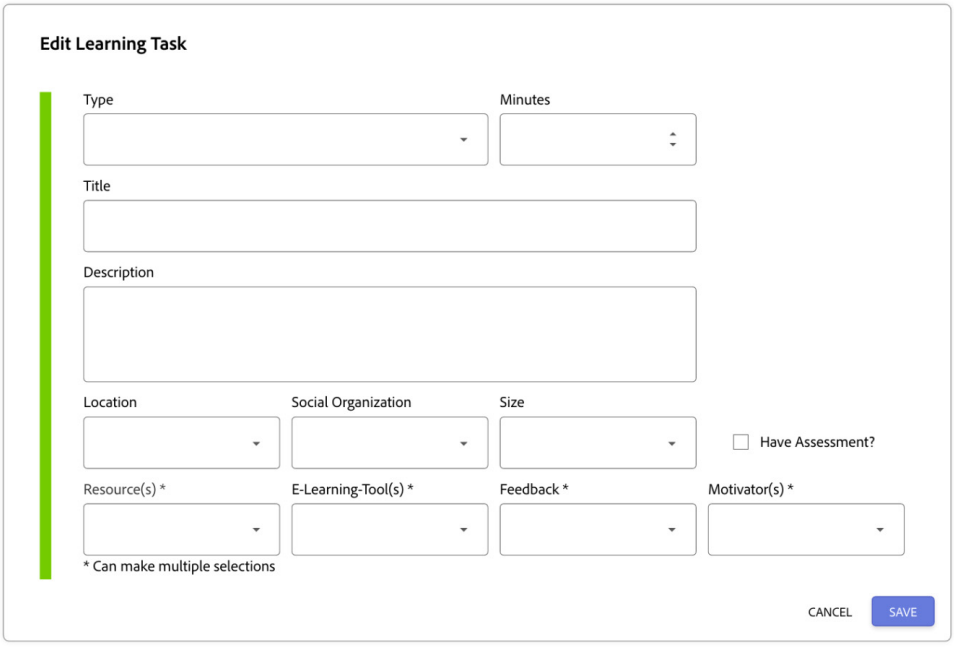


Figure 2 A graphical layout of the subtask settings in the description of a learning task



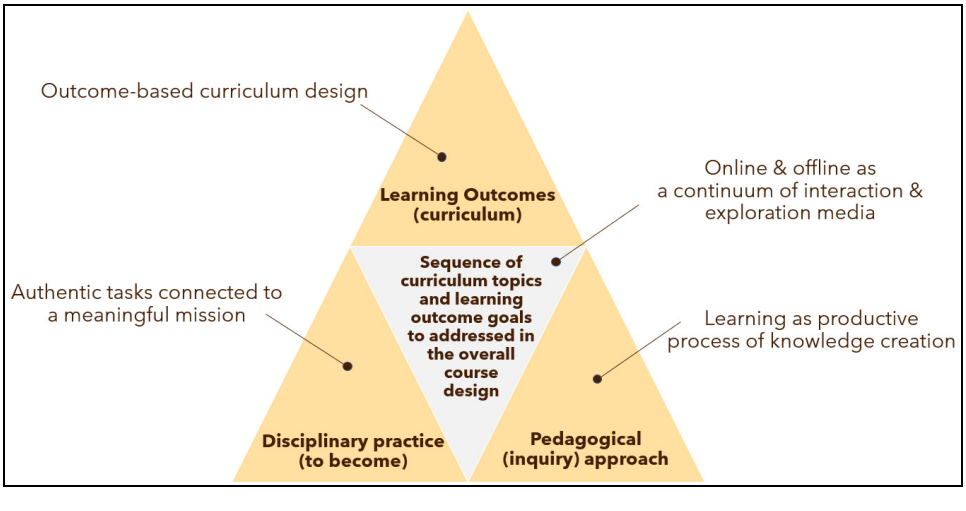
2.2.3 The learning design triangle – a conceptual guide to connect learning outcomes, pedagogical approach and the overall course design structure

As mentioned earlier, LDers have difficulties in applying abstract pedagogical principles or approaches to the design of curriculum units or courses. Literature that connects the core features of a pedagogical approach to specific disciplinary practices is thus particularly helpful to those interested in understanding the complex nuances involved in the operationalisation of a pedagogical approach to their specific course context. For example, Bridges et al. (2012) provided a rich and varied set of studies about the adoption of Problem-Based Learning (PBL) in different clinical education contexts. Providing close connections between pedagogical approach and disciplinary practice is helpful when the LDs involve authentic open inquiry as the nature of the problems and the steps taken to solve them differs across disciplines and contexts. Thus, Jonassen (2000) considered a shortcoming of student-centred inquiry approaches, such as PBL, as the lack of in-depth analysis of the underlying problems presented to students. Clear articulation of the kind of problem involved is needed to guide instructional analysis and the design process. Jonassen (ibid.) identified 11 problem types based on analysis of hundreds of problems used in instruction, each described in terms of the associated learning activities, information to be provided to learners, success criteria, structure of the context and the level of abstraction. Some problem types are particularly relevant to specific disciplines. For example, trouble-shooting problems are often encountered by technicians, diagnosis-solution problems are particularly relevant in medical education and case analysis problems are popular in business and law schools.

In the context of our course, the novice LDers come from diverse backgrounds and hence they do not share the same disciplinary domain in terms of their LD context. We have thus adopted the Learning Design Triangle (LDT, Law and Liang, 2020) as a conceptual tool to guide the course participants in the process of developing an overall course design, including assessments, that articulates an alignment between the learning outcomes and the pedagogical approach (see Figure 3).

The LDT suggests that LD starts with a specification of the disciplinary knowledge and skills as well as non-disciplinary learning outcomes such as 21st century skills (e.g., communication, collaboration), and metacognitive skills targeted by the course. The next step involves a specification of the key stages in the adopted pedagogical approach. For example, a simple self-directed learning model may comprise five focal stages in the learning activities: goal-setting, self-planning, self-monitoring, self-evaluation, and revision (Hew et al., 2016). This would be followed by an identification of an authentic disciplinary context likely to require the application of the knowledge and skills targeted in the course curriculum. Such contexts are referred to as Disciplinary Practice (DP) in the LDT. Examples of DP include engineering design, scientific investigation, marketing communications, etc. The course designer then lays out the key steps in the selected DP. For example, a simple engineering design cycle could involve the steps of ask, imagine, plan, create, and evaluate and improve (Museum of Science Boston, 2020). After defining the three corners of the triangle as in Figure 3, the LDers can then construct a sequence of curriculum blocks, which will be referred to as Curriculum Components (CCs) that serve as the backbone for the overall course design. Each CC may be labelled with specific topics in the content curriculum if deemed desirable and mapped to the learning outcomes goals and specific steps in the pedagogical approach and DP adopted (Law and Liang, 2020).

Figure 3 LDT framework



2.2.4 A 7-step process model to guide the traversal across multiple levels of design

Different models to guide the LD process have been reported in the literature. Some focus on moving from the overall pedagogical intent to the general structuring of learning activities (Conole et al., 2004; Laurillard, 2012; Persico and Pozzi, 2015). Others focus on more detailed levels of design such as developing a lesson plan with individual learning activities and resources (Boloudakis et al., 2018; Conole, 2013; Toetenel and Rienties, 2016), or fine-grained design of content-based resources (Ronen-Fuhrmann and Kali, 2015). Hansen and Wasson (2016) argued that a complete LD cycle should incorporate Learning Analytics (LA) such that information about achievement outcome and student behaviour can be used to support pedagogical decision-making before, during, and after the executive of a designed course unit. However, none of these models encompasses a full LD cycle (Mor et al., 2015a) or provides support for the four-layers of pedagogical decision-making (Goodyear, 2005).

The LD course in this study adopted a 7-step LD process model (Law and Liang, 2020) that incorporates the LDT framework as well as the incorporation of LD-integrated learning analytics. The seven steps are: (1) grounding the LDT, (2) deciding on the sequence of curriculum components (CC), (3) determining the pedagogical strategy and task sequence in each CC, (4) deciding on the detailed setting in each learning task, (5) deciding on the key LA questions, (6) selecting LA solutions and (7) alignment check. The first four steps of this model guide the LD process from course level pedagogical approach and disciplinary practice decisions, through pedagogical strategies to be deployed for the design of each CC, to the detailed design of task settings, including the necessary resources and tools to align with the relevant pedagogical tactics. While students had to engage in steps 5 to 7 as part of their coursework, these three steps are not included in the present study as the students did not have an opportunity to implement their design course in authentic contexts that engage the targeted learners.

2.2.5 Learning design studio – an LD platform to operationalise a principled scaffolding for the LD process

In many design fields such as engineering and architecture, technology tools play a very important role in supporting designers in their everyday design work. Such tools need to be underpinned by the conceptual and process models of their users in order that they serve the role of a productivity tool for the designers concerned. Further, designers rarely work in isolation, but have to communicate and collaborate in conducting complex design projects. Thus, design tools in mature design fields share common design vocabularies and protocols.

In the LD literature, there are also descriptions of tools developed for use by LDers, e.g., CADMOS (Katsamani and Retalis, 2013) for the design of lesson plans to be deployed on Moodle, the CompendiumLD (Brasher et al., 2008) developed by the Open University UK to support LD work within their institution and LdShake (Hernández-Leo et al., 2011) developed by a group of researchers in Catalonia, Spain as a social network system for the sharing and co-editing of LD solutions. To-date, there is no commonly adopted LD language or workflow protocol within the LD communities. On the other hand, appropriately designed LD technology can play an important role in the

professional development of LDers. In the current study, we adopt Learning Design Studio (Law et al., 2017) as the technology platform for use by the students.

3 Research design

This study is conducted as qualitative research within the broad category of Design-Based Research (DBR; Collins et al., 2004; The Design-Based Research Collective, 2003) in which the goal is to advance theory and practice in the application of evidence-based design principles in authentic educational settings. The present DBR study can also be considered as a form of Teacher Inquiry of Student Learning (TISL; Hansen and Wasson, 2016) as the research is also led by the teacher of the course in which the study is conducted and the teacher-researcher investigates the effectiveness of the learning design developed through the analysis of students' learning behaviour and artefacts.

Students attending the course were invited to join the study, which lasted for three months and all 19 of them gave consent to join. Focus group interviews with each of the design groups were conducted at the end of the semester after the students submitted all their design artefacts. Each interview was about an hour. The research team transcribed the interviews and analysed the data after all of the six group interviews were completed. The first round of analysis began with identifying and categorising data expressing difficulties, challenges, and refinements in each design component. A code book was structured and developed by referring to the analytical framework and constructs derived from the first round of the analysis. To refine the first version of the code book, a well-trained researcher, as well as one of the instructors from the course was invited to perform inter-coder reliability check for one group's artefact. All three members of the course team met to examine and comment on the coding scheme and conduct several cycles of refinement. The intercoder reliability was 0.982, which ensures the rigor of the study.

3.1 The course context

The research participants in this study were Master level students enrolled in an elective course on *Learning Design and Technology.*

3.1.1 Course participants

All of the course participants (16 female and 3 male) held at least a bachelor's degree in an academic discipline related to education, information technology and/or instructional design. Some were full-time K-12 teachers or instructional designers in higher education institution, taking the course as part-time students, others are full-time students with a few years of work experience and interested in becoming teachers, instructional designers, or other careers as allied educational professions.

3.1.2 Course design

As described in the previous section, the course design was underpinned by three specific features. First, a conceptual framework, the Learning Design Triangle, was introduced to course participants as an operationalisable approach to generate the core sequence of

curriculum components based on the intended learning outcomes, pedagogical approach identified, and the subject matter discipline of the course concerned. Second, the course was structured around a 7-step LD model (Law and Liang, 2020) to guide the constructive alignment process (Biggs, 1996). Third, the Learning Design Studio, a technology platform underpinned by the 7-step LD model to support collaborative LD, was made available for use by all course participants.

The course adopts a social constructionist approach and assessment as learning is implemented throughout. Students were organised in 'interprofessional' groups of 3 to 4 members with diverse experience and disciplinary backgrounds to work collaboratively on designing a mini-course of 3 to 4 'lessons'. Each group was assigned an education level (primary, secondary, or post-secondary education) and disciplinary focus (STEM or humanities) for the mini-course to be designed by the group. Each group decided on the topic of their mini-course based on their interests/expertise.

Each week, students presented their design progress to make their learning visible, followed by comments, critiques, clarifications and the teacher's introduction of new concepts and resources for the next stage of design, and finishing with design studio time working in groups. The course was organised around eight 3-hour synchronous sessions. The first session was to introduce the course to the course participants and to ensure that they understand the course design and the engagement expected of them throughout the entire course. In each of the remaining seven sessions, the students would need to complete one part of their course design according to a set sequence and present to the rest of the class, and to receive feedback from their peers and their teacher. The themes and deliverables for the group presentations in sessions S2 to S8 are designed as follows, based on the 7-steps in the LDT framework (see Table 1):

Table 1 Course design based on the 7-steps LDT framework

LDT step	*Session*	*Theme*	*Deliverable*
1	S2	*Specification of course level learning outcomes*	Based on the Outcome-Based Approach to Student Learning (CETL, 2009), specify the following course level parameters for the mini-course that the group plans to design: the nature of the course, the overall Learning Outcomes (LOs), characteristics of the potential learners, course topic and duration.
1 & 2	S3	*Constructing the LDT to design the sequence of top-level CCs*	Refine the LOs, specify the Pedagogical Approach (PA) and the disciplinary practice (DP) and then apply the learning design triangle (LDT, Figure 2) to construct the sequence of Curriculum Components (CCs) for achieving the course LOs.
3	S4	*Determine the pedagogical strategy and task sequence in each CC*	Design the task sequence for at least some of the CCs for achieving the intended LOs, select the tasks to be used for assessment purposes, and use the designer dashboard on LDS to reflect on whether the tentative design demonstrates constructive alignment across intended LOs, profile of task types and the LOs associated with the assessment tasks.

Table 1 Course design based on the 7-steps LDT framework (continued)

LDT step	*Session*	*Theme*	*Deliverable*
3 & 4	S5	*Designing for cognitive outcomes*	For the key cognitive LOs to be achieved in the mini-course, identify the key tasks in the CCs designed to achieve them. Apply appropriate pedagogical strategies and/or tactics to refine the task setting designs for these key tasks, including the appropriate tools and resources to be used during implementation.
3 & 4	S6	*Designing for complex performance*	To achieve the key non-discipline-specific LOs, often referred to as 21st century skills or generic skills in the curriculum, requires designs that involve complex performance such as collaboration, critical thinking, problem solving, peer evaluation and feedback. Apply appropriate pedagogical strategies and/or tactics to refine the task setting designs for tasks that involve complex performance, such as the tools and resources for group collaboration, peer and whole class interactions, as well as the social organisation (e.g., group composition) for such tasks.
5	S7	*Assessment and feedback design, set learning analytics (LA) questions*	Refine the assessment tasks identified, including assessment task description, rubrics, etc., to be provided to students, the kinds of feedback to be provided to students and the LA questions that can help to inform appropriate feedback to students and the teacher.
6 & 7	S8	*Select LA solutions, course evaluation design for alignment check*	This final presentation will present some possible LA solutions (only descriptive) that can be used to address the LA questions identified, and the design of the course evaluation (incorporating LA results) as inquiry of student learning. Whether the course has achieved constructive alignment should be a key purpose of the course evaluation.

While the course design guided the students to accomplish their design of the mini-course in seven steps as listed above, it is clear that these seven design aspects are interdependent, and it was the design intention for this course that the students would incrementally gain deeper understanding of the key concepts, and in particular the multilevel, nested nature of design and the need for alignment as they work through the seven iterations of their design work.

3.2 Data collection and analysis method

To understand students learning progress and challenges, we collected two types of data: (1) all the artefacts created by students in the process of carrying out their learning design project: students' wiki entries that document their decision-making process and rationale, slides used by each group in their weekly presentations on their mini-course design process, their course designs documented in LDS, their course design implemented on Moodle and their mini-course outline; (2) post-course group interviews. The study was

approved by the University's Human Research Ethics Committee, and the consent forms were signed and returned by all the participants.

In this study, the students were grouped into six project teams, with three members each. To address RQ1, we made use of the assessment scores of the group projects, which graded the quality of each group's LD on the clarity and appropriateness of the design aspects listed in Table 2 in the context of the mini-course developed.

Table 2 Design aspects and quality criteria adopted in assessing the design quality of the mini-course LD artefacts submitted

Session	*Design aspect*	*Quality criteria*
1	Learning outcomes	clarity and appropriate connections across the course and CC level LO specifications;
2	Pedagogy	appropriateness of the pedagogical approach (PA) selected and its alignment with the pedagogical strategies and tactics adopted in the different course components and tasks,
3	Disciplinary practice (DP)	identification of a role and context for the learners that would provide a problem setting that motivates and guides students in inquiry-oriented learning activities for the selected disciplinary domain,;
4	Curriculum component sequence	generation of a sequence of CCs (coherent activity blocks), that provides an inquiry process that is compatible with the selected DP and PA, and with each CC addressing an integral part of the course Los;
5	Task sequence for three of the CCs	specification of the sequence of tasks for each CC, and the pedagogical strategy guiding the task sequence design to achieve the LOs identified for each of the three selected CCs;
6	Assessment and constructive alignment	the extent to which the tasks specified for assessment are appropriate for the LOs designated, and whether there is a full coverage of the LOs specified at the course and CC levels;
7	Social organisation, mode, resources and tools	for the selected CCs in 5, the extent to which students were able to specify at the task level the social organisation (i.e., whether the task should be accomplished at the individual, group, or whole-class level), the mode of learning (i.e., online, offline, synchronous, or asynchronous), learning resources and tools to be used;.
8	Learning analytics (LA) and feedback	identification of a few potentially challenging LOs and tasks, and propose the kind of LA and feedback that would be helpful for students.

As mentioned in the previous section, it was anticipated that students would deepen their understanding through the design iterations. While the deepening of understanding over time was observed in all the groups, the LD artefacts submitted by the students reveal great differences in the level of LD performance demonstrated by the six groups in terms of the quality of their designs. We answer the first research question on the most prominent difficulties encountered by the course participants by analysing the design artefacts to identify the most frequently encountered difficulties/misconceptions associated with the design aspects listed in Table 2. To answer the second research questions on how novice LDers change their conceptions during their course of study, we selected two of the student groups, the highest performing and lowest performing group to compare the design decisions and rationale for changes over the seven presentation

sessions (See Table 2), based on their wiki entries and post-course interviews. Two course instructors, who were also the authors in the research team, were responsible for grading the students' design artefacts based on the grading criteria in Table 2. The design artefacts submitted by all of the six student groups achieved satisfactory standard, varying from excellent to very good and good.

4 Findings: challenges encountered by novice learning designers

While there are many fine-grained differences in terms of the difficulties encountered by students, the most common difficulties are concerned with the specification of learning outcomes. To illustrate the students' difficulties, we draw on the data from three of the six groups that demonstrated the highest, medium, and lowest scores in their submitted LD artefacts. Table 3 presents the topics, disciplines, and targeted education levels for the three group's LDs, as well as the acronyms used to refer to the members in each group. Group A's project achieved the highest score and group C the lowest for their submitted mini-course design.

Table 3 Information about the topics, disciplines and targeted education levels for the three groups' LD

Gp	*Members*	*Topic*	*Discipline*	*Grade/targeted student level*
A	BY, KI, JW	Thermal insulation	STEM	Elementary level
B	OW, YY, YL	Social innovation for urban poverty	Humanity	Secondary level
C	LK, XY, YT	Basic academic skills for higher education students/ prepare for your first job	Humanity	Post-secondary education

4.1 Unfamiliarity with learning outcomes and preference to start LD with content and activity design

Whereas the program emphasised and required the course participants to start their mini-course design with specifying the course level learning outcomes, almost all of the students deviated from this stipulation and began with thinking about the learning activities and/or content resources. It appears that students were generally unfamiliar with the meaning of learning outcomes as a curriculum construct, and tend to confuse it with content topics, as shown in the next sections. The following excerpts from the post-course group interviews illustrates how the students approached the course design task.

Group A-JW: First we listed several topics…We intended to engage students in making a solar water heater. But we were more interested and familiar with the scientific experiment.

Group C-YT: We had a 6-hour group discussion about the learning activities after the first session. We were excited as we shared a lot of ideas for the learning activities. We believed all the learning activities were beneficial to our learners and we could not wait to design the course slides for each session…We did not pay attention to LOs...

4.2 Belief that learning outcomes are unambiguously embedded within content topics and course activities

There was a tension between the students' desire to work on the design of learning activities and resources, and the requirement that they present the course level learning outcomes as their first design decisions. So, all of the groups had to reluctantly retrofit LOs based on what they have collated for their mini-course after deciding on the topic and target group of students. How they approached the retrofitting task depended on the granularity they focused on in their initial design, which could be the content topics or the learning activities. The retrofitting strategy is revealed in the post-interview sharing by groups A and C.

Group A-BY: We searched some teaching cases from the internet and combine them with our thoughts. Actually, we have a time limit. So, we just chose some topics and learning outcomes that we can accomplish and do some adjustment.

Group C-YT: We did not pay attention to LOs... but we needed to submit the presentation, so we tried to match them up in our way… We spent a lot of time to design the learning activities before we consolidated the learning outcomes because we believed this was the way we learnt. My groupmate also shared with us how she learnt the academic reading skills by participating in the workshops and trainings.

4.3 Difficulties in conceptualising learning outcomes as distinct from learning activities

At the end of each presentation during the synchronous sessions, students had to conduct peer assessment of each other's design. The peer assessment rubric which was made available to the students as part of the course materials at the start of the course had a regular item on the appropriateness of the LOs in relation to the rest of the design. This provided an opportunity for the course participants to keep the alignment of LOs in sight as they further develop and refine their LDs. However, the group with the lowest performance was not able to conceptualise LOs as distinct from the learning tasks they designed for the students, as revealed in the Group C post-course interview:

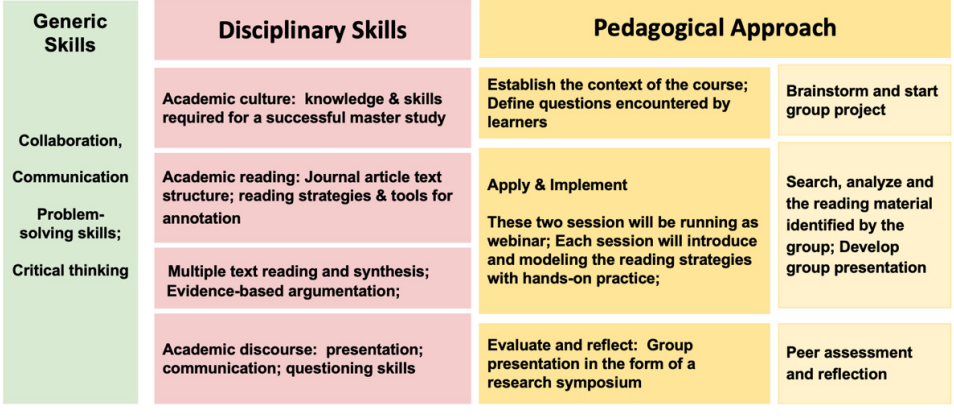
Group C-YT: We always had new ideas at the session level, and we tried to go back to modify the LOs at the top level… The reason why we changed the topic each week is that we were always going through disagreement on the boundary of the course design, and each team member defined a newer version of learning outcomes from her understanding. Therefore, we finally decided to first set the learning activities and time for each session, and then went back to define the learning outcomes.

4.4 Difficulties in using Bloom's Taxonomy to specify the cognitive learning outcomes

Students were required to specify the level of achievement to be attained for each of the specified LOs using Bloom's Taxonomy (BT, Anderson et al., 2001). However, some lower performing groups, had serious difficulties in using the levels and verbs in BT to specify the knowledge and skills outcomes. Figure 4 shows one of slides in Group C's presentation that illustrates the group's difficulties. Under the first two columns labelled

respectively as generic and disciplinary skills, the terms used are general descriptions that do not contain any of the six verbs (remember, understand, apply, analyse, evaluate and create) indicating the BT outcomes levels targeted. The third column – pedagogical approach – was further subdivided into two columns. Each of the boxes on the left contains some relevant verbs, some of which are overall level verbs such as apply and evaluate, as well as some finer grain activity verbs such as define. The right-most column similarly contains both kinds of verbs, although more of the verbs are at the specific activity levels such as brainstorm, and search. Both columns contain descriptions of activity formats such as presentations. None of the statements connect the verbs with specific knowledge and/or skills to be demonstrated through the performance of the activity.

Figure 4 Group C's presentation slide (in S3) on the specification of LOs for each of the four sessions in their mini-course



5 Findings: whether and how novice learning designers improve in their LD practice

All of the students improved in their understanding and application of the key concepts listed in Table 2 as demonstrated in the evolution of their design artefacts over the duration of the course. As presented in the previous section, students had the greatest difficulties in understanding what are learning outcomes, how these need to be specified at course, CC and task levels to achieve constructive alignment. In answering RQ2, due to the limitation of space, we focus in this section on tracing how Group C, which had the greatest challenges in understanding and making appropriate specifications of LOs for their mini-course, struggled with their challenges and modified their understanding and LD practice over time. We first provide in Table 4 an overview of the students' learning trajectory by highlighting the key design foci and articulation/deviation of their design focus with the course stipulations in each of the presentation sessions.

Table 4 An outline of Group C members' key design foci for their presentations from S2 to S8, and how these articulated or deviated from the course stipulations

Session	*Key design foci and artefacts generated*	*Articulation/deviation from course stipulation*
S2	• Identified course level parameters: topic, education level of target students, number of synchronous sessions. • Identified key learning activities in each session and specified all assessment tasks. Retrofitted LOs for presentation.	• Students were not advised to design activities, session focus or assessment at this stage. • Students mimicked the format of LO specifications in the course outline, with descriptions that comprise some Bloom's Taxonomy verbs and observable activities.
S3	• Constructed the LDT for their course design, specifying LOs, PA, DP and CCs for the entire course. • Constructed learning tasks for the first two sessions.	• LOs broadly similar to those in S2. • PA in LDT diagram: inquiry-based learning, suitable. • Confusion about PA as shown in Figure 1. • DP: not able to specify a disciplinary role and authentic context as a setting for the inquiry learning activities (academic reading and academic discourse listed) • CCs: reasonable sequence of three CCs, but entirely different from the session activities provided in S2.
S4	• Revised the course level outcomes to include Bloom's Taxonomy verbs and increased specificity of the outcomes, e.g., 'understand structure and patterns in academic texts'. • Revised the DP to 'reading skills, speaking and communication skills'. • Revised the session tasks.	• Demonstrate a better understanding of LOs. • Still did not understand DP, changed DP specification from learning activity to LOs (skills). • CC unchanged but has no connection with the revised session tasks. • The set of session tasks in S3 had more inquiry orientation aligned with specified PA, revised tasks are all didactic. • Summary: alignment reduced rather than improved.
S5	• Further refined the course level LOs and specified the session level LOs • Revised the detailed design for the first two sessions.	• The course level LOs were revised to become more specific: connecting a Bloom's Taxonomy verb with a specific LO, e.g., 'To apply techniques such as concept map to help represent the understandings of texts'. • Good articulation between course level LO and session level outcomes • Increased inquiry orientation in revised task list. • Concept of CC ignored.

Table 4 An outline of Group C members' key design foci for their presentations from S2 to S8, and how these articulated or deviated from the course stipulations (continued)

Session	*Key design foci and artefacts generated*	*Articulation/deviation from course stipulation*
S6	• Decided to re-start their entire design on a completely different topic: *Preparing yourself for job interviews*. • Started the new topic by following strictly the 7-step LDT framework to specify the course LOs using Bloom's Taxonomy verbs. • Decided the DP to be '*Success in job seeking'* and listed the required tasks: self-assessment, develop job-search skills, apply marketing strategies to impress recruiters. • Identified PA to be *Problem-based Learning*. • Developed the learning tasks for each of four sessions. Did not use the term CC to refer to the sessions, but in fact each session has all the feature of a CC: specific LOs, task sequence and assessment.	• While this group had to restart 'from scratch', they were able to achieve all the required LD artefacts up to S4 that achieved constructive alignment by applying the concepts associated with the LDT appropriately. • The group still had difficulties in conceptualising CCs, and defined their CC to be all of the group work in the mini-course. In fact, the way they structured their sessions, each session could be correctly referred to as a CC.
S7	• Refined the LOs and alignment with the session LOs and the session tasks. • Refined the sequence of the sessions according to the steps that job seekers would need to go through. • No mention of CCs in the wiki design log.	• Group C finally understood the meaning and purpose of DP: providing an authentic context and structure for organising the LOs and associated learning activity blocks (i.e., CCs).
S8	• Further refined the title of the mini-course to '*Prepare for your first job*'. • Presented the course LOs with a graphic that shows a clear mapping of each LO to the targeted level of performance in the Bloom's Taxonomy. • There was still no mention of CCs in the design logs. • Developed a clear table that mapped the intended LOs with on-going (formative) and summative assessment tasks.	• Group C has come a long way to develop a relatively robust design and provided the required LD artefacts up to those stipulated for S7. • The learning analytics and feedback design was still in the works, which the Group were not able to present.

As can be seen from Table 4, over the first four sessions, Group C had been struggling with their design tasks. Their engagement as shown in the activity logs in the Learning Management System and their design logs in the project wiki show that they were in fact very interested in the course design project and really wanted to jumpstart the whole

design process. Unfortunately, their intuitive bias towards the design of learning tasks and resources as the focal anchor for their course design led them into trouble. Actually, from S3 onwards, the Group was trying to follow the instructions. However, the alignment across the different components of their LD was in fact lowered in S4. In their preparation for S5, students had to design/refine their task designs for the achievement of identified cognitive outcomes. during this process, Group C students had to put much of their efforts into the design of learning activities and assessments for each session, and in the process realised the importance and the challenge of ensuring alignment across the different levels of design. The dilemma experienced by this group of students is vividly expressed by one of the group members in the group wiki design log:

Group C-XY: At the first session, we created a course outline (including assessments) to clarify our project at the first stage (I think things started to go wrong from that moment) because we thought if we could have created the outline surely we could show others how it would work. Now I realise it is counterproductive. We cannot explain well the LOs of our CD [course Design] from the very beginning, then the following weeks we again and again [tried] to revise the CLO and content [and] spent much time but few outcomes [resulted].

In fact, the topic they have chosen for their mini-course – *Basic academic skills for higher education students* – was beyond their academic and professional expertise, which added to their LD challenge. The students chose this topic because they found this to be an important topic, but were not aware this lack of disciplinary expertise constituted a challenge for them. However, they rationalised their need for topic change during the post-course interview as due to the short course duration, and that the new topic – P*repare for your first job* – was more specific.

Group C-LK: The previous learning outcomes are more general and a bit ambitious for a mini-course. So, we narrow them down to: 1) understanding about self, 2) understanding about the intended positions [to apply for], 3) explain the match [between] you and the position, 4）practice interview skills and map it [to] the four sessions. Each session has a clear learning objective and aligns with our designed assessments

Students were given the opportunity to further revise their mini-course LD after S8 for their final project submission. Group C's final submission provided clear and appropriate depiction of the CCs in their LD. Two of the group members described how they arrived at their new understanding of CC during the post-course interview.

Group C-YT: We tried different ways until we discussed several times with different classmates in other groups and then we understand what CC means…We finally used a fix structure to plan the CC like 'to do [achieve] A by/ through B'. A is the goal and B is the method that can be the activities, steps from the PA or the resources we provided.

Group C-XY: Our group adopted project-based learning as the PA and there are 5 steps defined in the project-based learning. Again, I use my first language to explain the flow of CC in our own context. We realised that CC sequences show what students experience in the course instead of a unit of activities under each session. We also refined our LOs based on the new CCs.

6 Discussions

LD is a complex process requiring the application of design principles at multiple levels of pedagogical decision-making. As a Design-Based Research (DBR; Collins et al., 2004; The Design-Based Research Collective, 2003), we were interested in identifying the most prominent design challenges encountered by novice LDers participating in the *Learning Design and Technology* course. The course design was guided by the 7-step LDT framework and used LDS as the LD platform. We found that designing LOs that are aligned at course, CC and task levels was a prominent challenge to all of the student groups. The groups' ability to advance their design in terms of coherence and refinement were very much limited by the extent to which the students were able to differentiate learning outcomes as a curriculum construct from the content topics and learning activities in the LD. We identified four common problems in students' design practice regarding the design of LOs. First, all of the students were unfamiliar with the concept of learning outcomes and preferred to start their LD by specifying the content topics and designing instructional activities. This reflects a confusion between the purpose of the design and the means to achieve the goal which becomes the ends themselves (Anderson et al., 2001; Bennett et al., 2016; Nguyen and Bower, 2018). Second, there was a belief that LOs are unambiguously embedded within content topics and course activities, and thus one can easily retrofit the intended LOs after the learning tasks or resources are determined. However, in actual pedagogical practice, the implementation of the same learning task (e.g., a role play) or the use of the same resource (e.g., a video) could be very different, depending on the LO targeted. These two problematic design practices relate to two further conceptual difficulties associated with the specification of learning outcomes. The first was the difficulties in handling abstract conceptualisations. LOs are abstractions about what students are expected to be able to do under a variety of different contexts after completing the course. Learning activities and resources are observable and concrete. As described in Sub-section 4.3, lower performing students had greater difficulties in differentiating LOs from learning activities. Another conceptual difficulty was the inability to distinguish among ontologically different concepts. As reported in Sub-section 4.4, some students were not aware that knowledge, skills, the nature of students' engagement in the learning tasks (as described by the BT verbs), and the design of activity formats (describing the task settings) are distinct elements in LD, even though these are related. Both conceptual difficulties are mainly found in the lower performing groups, indicating that the challenges they face are not only due to their unfamiliarity with LD concepts and practices, but also their general academic ability to handle abstraction and ontological differentiation of concepts.

The study also found that by reinforcing the need to demonstrate alignment at the different stages of design, the course helped all of the groups to understand the need for alignment in terms of the LOs at course, CC and task levels, and between intended LOs and assessments. In addition, the LDT was found to be helpful by all of the groups, including Group C, to be useful in guiding them to connect the LO, PA and DP to develop a compatible sequence of CCs for a coherent course design. The 7-step framework also helps to provide a guide for the LD process. In addition, by requiring that students use LDS as a representational tool to present their LD, the novice LDers became more aware of the different levels of design granularity and the associated LD language (Law et al., 2017), as the tool helped to make explicit the theoretical underpinnings and the development of detailed learning tasks for implementation (Conole et al., 2004;

Persico and Pozzi, 2015). The designer dashboard provided by LDS also provided visualisations for the users to check the alignment across LOs, assessments and the profile of learner experiences based on the tasks.

On the other hand, both the design language and the tool were unfamiliar to students. All of the groups had to spend time to familiarise with the conceptual framework and to adopt them in their design practice. It also appeared that those students who were more proactive in frontloading their LD by creating design artefacts, and those who were less familiar with the subject domain of the course they were creating (as in the case of Group C), experienced greater difficulties in recognising their misconceptions and to follow the 7-step framework closely in their design.

7 Conclusions

This paper reported on a study of novice LDers taking a master's level course on Learning Design and Technology. LDT and the 7-step LD process model (Law and Liang, 2020) was adopted as conceptual tools to guide students in the design process from the specification of course learning outcomes and characteristics of targeted students through to the detailed design of task sequences, resources and task settings, while keeping a close adherence to a coherent pedagogical framework comprising four nested layers of pedagogical decision-making. Students' LD process was supported by a technology platform, the Learning Design Studio (LDS). The findings reveal the challenges encountered by course participants. Further, the conceptual and technological LD tools used in the course fostered the articulation of pedagogical reasoning and helped to reveal incoherence and misalignment in the design artefacts.

Findings from this study revealed several issues that could be further examined. First, the LDT framework is relatively complex with many key LD concepts that are interrelated in nature. The whole program spanned eight 3-hour synchronous sessions as well as sustained support for student-directed learning from course facilitators. The findings about the challenges encountered by the novice LDers are consistent with those reported in the literature. However, the trajectory of students' understanding and how their design practices progressed through the course may not be generalised to other LD training settings and contexts. Future studies could investigate how the LDT and LDS could be deployed in different educational settings, user groups and course durations. The 7-step LD process model would need to be broken down into smaller chunks to make it more versatile for adoption while retaining the focus on coherence and constructive alignment across the smaller chunks. A particular challenge for future work is in adapting these conceptual and technological tools for use in professional development events for in-service teachers, which are typically in the form of one-off or a short series of seminars and workshops. Only when these conceptual and technology tools are adopted by a wide community of in-service teachers and LD practitioners can the (Law et al., 2017)'s vision for LDS to become a knowledge management and professional sharing platform for a LD community of practice be realised.

More focused LD professional development units could be developed on the basis of the findings from the current study. For example, there could be workshops that provide novice LDers with opportunities to explore retrofitting LOs from representations of learning activity sequences and resources. This could help them realise that different LOs could be realised through the same set of activities and resources. Workshops on

analysing the different levels of design granularity and/or the pedagogical coherence and alignment across design levels and elements from samples of authentic LDs would also be good preparations before introducing them to the concepts underpinning LDT and LDS. Another direction for future work is to populate LDS with useful design patterns at course, CC and task levels so as to help novice LDers to understand the concepts of nested levels of pedagogical decision-making and constructive alignment, in addition to serving as a repository of good design ideas and practices.

Further, our findings show that students' difficulties in conceptualising LOs and specifying them using the Bloom's Taxonomy may result not only from their unfamiliarity with LD concepts and practices, but also their inadequate academic ability to handle abstraction and differentiate ontological differences among concepts. This implies that future courses on LD should build in support for these more general conceptual difficulties in order to help weaker students to succeed.

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