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Developing a Challenging Online Doctoral Course Using Backward and Three-Phase Design Models

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Overview

A team of one instructional designer and one faculty developer/instructor designed and taught Current Practices and Future Trends in Aviation (DAV 735), a doctoral course in the first-ever Ph.D. in Aviation program in the world. The instructional designer was responsible for all developments of the course, including designing the learning activities, editing the course content, creating the multimedia, overseeing the video productions, building the course in the learning management system (LMS), and maintaining its quality and function. Likewise, the professor provided the context (vision) and subject matter expertise during the initial development and subsequent updates of the course and taught all offerings of the course. The continuity of this professional collaboration provided the opportunity for a longitudinal, descriptive case study (Dobson, 1999) reporting on a multi-theory approach using the three-phase design (3PD) model by Sims and Jones (2003) and the three-stage backward design (BD) model by Wiggins and McTighe (2006) in designing a challenging online doctoral course.

Current Practices and Future Trends in Aviation is one of 19 online courses in the Ph.D. in Aviation program at Embry-Riddle Aeronautical University (ERAU). Since its first offering in 2011, it has run five times through 2014, with enrollments ranging from three to 13 students per 12-week term, resulting in 31 doctoral students completing the course successfully (i.e., course grade of A, B, or C), two failing (i.e., course grade of F), and five withdrawing (one student represented three withdrawals and one failure). In the annual worldwide competition for blended and online courses delivered in the Blackboard® Learn LMS, DAV 735 won a Blackboard® Catalyst Exemplary Course award in 2014.

The purpose of this case study is to address the gap in the literature describing practices of instructional design and development (IDD) teams in terms of how theories are applied

(Yanchar, South, Williams, Allen, & Wilson, 2010). The literature tends to focus on theory rather than practice; therefore, we present a shared perspective of both why we selected design theories and instructional theories and how we applied them in this course. This paper begins with background on why creating online courses is challenging and why DAV 735 was particularly challenging. Then we discuss our selection rationale for the design models and instructional strategies employed. Next, we present the specifics of the initial course design and development and its ongoing improvements framed within the chosen theoretical contexts. We conclude by offering suggestions to inform future IDD practices and research.

Background

Instructional design complexities of new online courses are ill-defined problems because their specifics are unclear (Simon, 1973; Jonassen, 1997; Jonassen, 2000). Initially the users' needs, user-interface (UI) design, user-experience (UX) design, functional specifications, content requirements, and information architecture are all abstract problems (Garrett, 2003). It is not possible to understand fully the needs, goals, and objectives of the students and instructor without contacting these stakeholders. Yet, while development of an online course often involves some degree of collaboration between an instructional designer and a subject matter expert (SME), the SME will not necessarily be the instructor of the course. Furthermore, the IDD process does not usually include input from students and instructors. Although it is common for design teams within industry to perform usability tests before launching a new product, this is not usually the case within academia. Students are not routinely available to instructional design teams to participate in online course usability tests. In the absence of such testing for new course designs, it is not possible to predict how instructors and students will interact with the function of the computer interface. Nor is it possible to predict what their experiences will be with the design of the visual content, the presentation of the information, and the learning technology and tools. Consequentially, the instructional design team must identify and remedy the UI and UX problems after the course has run. Even when design problems are uncovered, their problems and solutions can remain unclear and elusive. For example, simply expressing dissatisfaction about a particular collaboration activity does not identify the root cause for the IDD team to address. The problem could be with the UI design or with the UX design. Consequently, the solution is uncertain. The problem would need better definition, possibly even undergoing several iterations of refinement and use cases, before finding the best solution. However, even when users provide detailed feedback about a problem, without a consensus about what the specific issue is, the problem and its solution become considerably more challenging. Indeed, it can even become what some have termed a *wicked* problem (Jordan, Kleinsasser, & Roe, 2014; Rittel & Webber, 1973).

Framing a problem is an essential step toward finding the best solution. Rittel and Webber (1973) list the following properties that define wicked problems:

1. There is no definitive formulation of a wicked problem.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. Every solution to a wicked problem is a ‘one-shot operation’; because there is no opportunity to learn by trial-and-error, every attempt counts significantly. Every implemented solution is consequential.

6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.

7. Each wicked problem is essentially unique.

8. Each wicked problem can be considered a symptom of another problem.

9. The existence of a discrepancy representing a wicked problem (causes) can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.

10. The planner [designer] has no right [latitude] to be wrong. (pp. 161-167)

Most design problems are wicked problems owing to their dynamic complexities and the many disparate viewpoints, competing interests, and diverse convictions of their stakeholders as to the solutions (Rittel & Webber, 1973). Irlbeck, Kays, Jones, and Sims (2006) and others (Jordan et al., 2014; Kays & Francis, 2004) assert the complexity of interactions makes the instructional design of online courses a wicked problem. Dynamic complexities vary by the type of online interaction, so it is necessary to differentiate the types of instruction. Traditional courses are 100% face-to-face instruction, web facilitated courses have less than 30% of the instruction delivered online, blended or hybrid courses have 30% – 79% delivered online, and online courses have more than 80% delivered online (Allen & Seaman, 2013, p. 7). Learning interactions are symmetrical when information flows both ways between the instructor and learners, as with face-to-face class discussions or postings on an online discussion board; learning interactions are asymmetrical when the information flows largely in one direction, typically toward the students, as with instructor lectures delivered face-to-face or online in a document or video (Holden & Westfall, 2010). Interactions can occur synchronously (e.g., audio/video/web conferencing, chat, phone, virtual labs/worlds) and asynchronously (e.g., collaborative documents, discussion boards, e-portfolios, email, learning object repositories, wikis). Consequently, the IDD process must address the unknowns associated with the online LMS, diverse learning interactions (e.g., student-to-content, student-to-student, student-to-mentor, and student-to-instructor), different types of delivery methods, and the emergent needs of the users.

It is incumbent upon instructional designers and practitioners to be responsive to demands from students, instructors, and universities. Yet, classic linear approaches to IDD that are characterized by analyzing, designing, developing, instructing/implementing, and then evaluating—the ADDIE model (Branson et al., 1975)—are not always responsive enough to the emergent needs of students, faculty, and universities (Irlbeck et al., 2006; Sims & Jones, 2003; Kays & Francis, 2004). The common explanation is that the process is awkward, takes too long, and is too rigid (Gordon & Zemke, 2000). Furthermore, dynamic advancements in e-learning technologies often result in quick-to-market improvements that compel instructional designers and practitioners to make continual revisions in courseware.

The 3PD model is an IDD process capable of addressing emergent needs of students and instructors concerning course quality, workload, and usability of delivery technologies—and doing so within budgetary constraints (Sims & Jones, 2003). The 3PD model accommodates a more fluid response to learners' needs by taking competitive advantage of rapid prototyping much like how computer software developers use short, iterative development sprints to deliver functional components to clients as the product is being developed (Cunningham, 2001). The idea is to transition quickly from concept to implementation to find out how users will respond and then make informed modifications. Typically, the 3PD approach relies on a small IDD team made up of an instructional designer/course builder and subject matter expert (SME)/instructor, making the IDD process more agile and less costly compared to a large production team.

As a reflective IDD approach, each iteration of the course allows for improvements both during and after course delivery in response to feedback from students and the instructor. It is important to realize that incremental improvement, no matter how small, is essential to complex systems. Granted, small changes may not seem like much when made, but, when aggregated over time, the gain grows more noticeable until it can become the difference between excellence and mediocracy (Clear, 2015).

The original 3PD model (Sims & Jones, 2003) has three phases. The objective of Phase 1 is to develop a fully functional course that meets the desired learning outcomes and established program goals. The objectives of the subsequent phases focus on maintenance and implementing small enhancements or major modifications as needed. Irlbeck et al. (2006) explain:

> The first iteration or phase allows for the emergence of learning environments which [*sic*] provide functional delivery with the necessary componentry for effective online teaching and learning, including any necessary scaling to the teaching and learning context. The objectives of Phase 2 are to evaluate the live implementation of the course and make improvements by elaborating on its content and enhancing its design and delivery. Within the second and subsequent iterations, development can be enhanced with each cycle of change, supporting generative learning environments and the adaptability of the model to incorporate evolution of locally developed solutions so the learning environment can grow organically with scope to develop schemas and frameworks. (p. 179)

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Table 1 provides definitions for each phase of the classical 3PD model.

Table 1

Three-Phase Model Definitions

Phase: Focus	Definition
Phase 1: Function	"The aim is to design and create a functional online teaching and learning environment that will meet learning outcomes as well as departmental teaching and learning strategies" (p. 180).
Phase 2: Evaluate, Elaborate, Enhance	"The second phase is conceptualized to occur during the learning unit, with feedback from teachers and learners used to modify and enhance the environment" (p. 182).
Phase 3: Maintain	"Following completion of the learning unit, additional modifications and enhancements are prescribed and implemented for subsequent delivery" (p. 182).

Note. Adapted from "The Phoenix Rising: Emergent Models of Instructional Design," by S. Irlbeck, E. Kays, D. Jones, and R. Sims, 2006, *Distance Education, 27*, pp. 180 & 182. Copyright 2006 by Distance Education.

The development of new online courses at ERAU adheres to a quality-controlled production process (Holsombach-Ebner, 2013). It begins with a kick-off meeting with key stakeholders (e.g., IDD director, instructional designer, faculty developer, and academic program chair) to discuss the IDD process and milestones and schedule the ensuing steps. Next, the designer and developer meet to discuss and develop specific learning goals, objectives, assessments, and activities. Once the developer delivers the content for the first two modules, the instructional designer builds them in a production template in the LMS. Then these modules undergo a quality review by another instructional designer and an academic review by the program chair. After implementing any needed revisions, the instructional designer builds the next two modules. As with the first two modules, they undergo quality and academic reviews, and this cycle repeats until the completed course template receives its final academic approval. (See Holsombach-Ebner, 2013, for a comprehensive analysis of the IDD process at ERAU, including its theoretical foundations.)

We would follow this production process; however, we needed an IDD framework for handling the three wicked challenges:

1. The Ph.D. in Aviation student body comprised largely of multidiciplinary aviation professionals.
2. No seminal textbook on the course topics.
3. Internet technologies carrying unforeseen usability difficulties.

The three-stage BD model would allow us to address the first two challenges by designing the course around learning outcomes as opposed to topic objectives from a textbook and by leveraging the prior expertise of the students. The 3PD model would provide a responsive approach to the third challenge through iterative development and improvement of the course.

3PD Model Phase 1: DAV 735 Design and Development

Our application of the 3PD and the BD models was somewhat unique. To begin with, we performed the three stages of the BD model within Phase 1 of the 3PD model. We developed the learning outcomes in Stage 1, created the assessments and rubrics in Stage 2, and designed the activities and built the course out in Stage 3 (Wiggins, 2005; Wiggins & McTighe, 2006), completing Phase 1 as illustrated in Figure 1. During the implementation in Phase 2, we shifted the evaluation, elaboration, and enhancement—what we call the triangle of improvement—toward Phase 3.

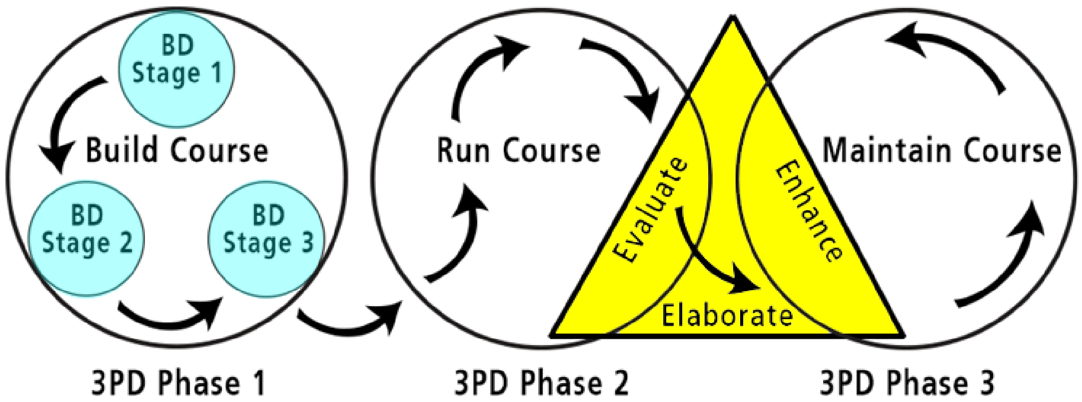

Figure 1. Conceptualization of the unique instructional design and development process of DAV 735 deploying the Backward Design (BD) model within an adapted 3-Phase Design (3PD) model by shifting the improvement triangle toward Phase 3.

Backward Design Stage 1

In accordance with the three stages of the BD model, we began Stage 1 by "unpacking" (Wiggins, 2005, p. 7) the program educational goals (PEGs) by asking learner-centric questions to arrive at the transferable skills, understandings, and knowledge students would need to have upon successfully completing the course. The course design challenges led us to ask what the students would need to do as doctoral scholars and why. We agreed with the literature showing this tactic would sustain learning transfer (Bryan, 2015; Washer, 2007). For example, information literacy, knowing how to find and use salient information, would be more transformative than simply recalling information because a lot of information tends to become outdated quickly. Therefore, unlike textbook-based courses that emphasize declarative knowledge acquisition, we concurred with Bryan (2015) and O'Driscoll (2015) that approximately 70% of the learning focus should be on what the students need to do, 20% on what they need to believe, and 10% on what they need to know. Our next task was to determine what types of skills doctoral students need to learn.

Washer (2007) proposed the adoption of nationally recognized skills for higher education based on six categories of skill performances: “communication, working with others, problem solving, numeracy, using information technology, learning how to learn, and personal and professional development” (p. 65). In addition, he asserted doctoral students should be able to demonstrate the Level-6 honors skills categorized in Table 2 upon successful completion of a Ph.D. curriculum.

Table 2

Level 6 Honors Skills

Category	Sample Criterion
Communication Skills	Write situationally appropriate, detailed, cogent communication on complex subjects
Working with Others	Recognize, support or take on a leadership role in a group activity
Problem Solving	Critically analyze the problem
Numeracy	Manipulate, analyze, present numerical data (including using charts, diagrams, graphs)
Use of Information Technology	Manage information, competently undertake research tasks with little guidance
Learning How to Learn	Use all resources responsibly and independently Apply own criteria of judgement to work and challenge received opinion
Personal/Career Development	Prepare a curriculum vitae

Note. Adapted from “Revisiting key skills: A practical framework for higher education” (p. 65) by P. Washer (2007). Copyright 2007 *Quality in Higher Education, 13*(1), 57-67. This list includes a few skills from each category that are representative of skills developed in the Ph.D. in Aviation program. Please see Washer (2007) for the complete list.

The Ph.D. in Aviation curriculum encompasses the Level 6 honors skills as broadly articulated in the PEGs listed in Table 3.

Table 3

Ph.D. in Aviation Program Educational Goals (PEGs)

Number	Goal
PEG 1	Develop mastery of the central theories and concepts in the field of aviation, including foundations, safety management, economics, and regulatory procedures.
PEG 2	Pose and solve theory-based and research-based problems designed to advance applications in the field of aviation.
PEG 3	Extend aviation body of knowledge by conceiving, planning, producing, and communicating original research.
PEG 4	Acquire expertise in instructional processes.
PEG 5	Demonstrate leadership, collaboration, and communication necessary for scholarly work in aviation.

Note. Adapted from "About the Ph.D. in Aviation," by the Ph.D. in Aviation, 2015, Department of Doctoral Studies, para 2. Copyright 2015 by Embry-Riddle Aeronautical University.

Redecker (2009) proposed that students must curate and synthesize information, collaborate in social networks to achieve common goals, become active learners through authoring and co-authoring works, and take greater personal responsibility in what and how they learn. In accordance with this paradigm and the behavioral focus proposed by Washer (2007), we developed skill-based course goals to support achievement of the PEGs. These goals focused on students producing a variety of in-depth technical papers related to current practices and future trends in aviation, collaborating to identify issues of regional, national, and international concerns, and evaluating the strengths and weaknesses of alternative solutions, conclusions, or approaches to far-term aviation-related needs and problems.

We determined that problem-based learning (PBL), a constructivist instructional approach based on cognitive psychology (Savery, 2006; Shankar & Nandy, 2014), would be appropriate for all three of the design challenges. From the models of PBL, we chose the student-centered PBL model because students could construct disciplinary knowledge by leveraging individual prior knowledge and collective understandings developed in social learning environments to identify and solve real-world problems (Savery & Duffy, 1995; van den Hurk, 1999). We identified self-directed research (Shankar & Nandy, 2014) and publishing in peer-reviewed aviation literature as the chief accomplishment and assessment. In addition, we wanted all other coursework and activities to support achieving this publishing outcome while also developing additional scholarship skills.

Informed by the course goals and approximating a 70/20/10 approach to the student-centered PBL model, we established six fundamental skills or behavioral understandings as the foundation for the learning outcomes.

- Analyze and synthesize literature
- Review scholarship critically
- Lead and collaborate in knowledge development
- Prepare and publish scholarship
- Create learning assessments and evaluate knowledge
- Demonstrate and defend learning transfer

From these understandings, we developed six behavioral, student-learning outcomes (SLOs) as shown in Table 4, framing each SLO within the context of current practices and future issues in aviation and aligning each SLO to the established PEGs.

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Table 4

Student Learning Outcomes (SLOs)

Number	Outcome
SLO 1	Lead, observe, and evaluate collaborative work to determine progress, provide feedback, and make suggestions for improvement (PEGs 1, 3 - 5).
SLO 2	Analyze and synthesize relevant research to identify current stakeholders, practices, issues, emerging technologies, future trends, and far term forecasts in aviation (PEGs 1 - 3, 5).
SLO 3	Review scholarly works; critiquing the type and quality of contribution, content, and writing style according to common practices for the submission process for professional publications (PEGs 1, 5).
SLO 4	Based on synthesis of relevant academic literature, author publishable works in which current solutions, conclusions, or approaches to future aviation-related needs are evaluated and alternatives or recommendations are proposed (PEGs 1 - 3, 5).
SLO 5	Develop qualitative evaluation items and their answers aligned to a learning outcome that evaluate knowledge and concepts, procedures and performances, or problem solving and reasoning applied to current practices, issues, emerging technologies, and future trends in aviation (PEGs 1, 4).
SLO 6	Create an outcomes-based personal portfolio that provides evidence of and an argument for achievement of each course-learning outcome and the best learning strategy used in achieving those outcomes (PEGs 1, 3, 5).

Note. PEGs = Program Educational Goals.

Next, we developed broad objectives to support development of the desired outcomes. As with the learning outcomes, the objectives focused on skill development within the context of the course subject matters spanning current practices to future trends and issues in aviation.

Backward Design Stage 2

The first step in this stage involved identifying appropriate evidence of achievement of the skills, understandings, and knowledge, and then creating the assessments; the second step involved determining the degree of achievement, and then creating the evaluation rubrics (Wiggins, 2005; Wiggins & McTighe, 2006). Before developing the assessments and rubrics, we had to formulate an overarching learning strategy that would account for the lack of a seminal textbook for the course. The practical solution to this design challenge was to take advantage of the aviation expertise of the students through collaborative learning vis-à-vis constructivist learning tools and environments (Conradie, 2014).

Communal constructivism (Holmes, Tangney, FitzGibbon, Savage, & Mehan, 2001; Jonassen, Davidson, Collins, Campbell, & Haag, 1995; Leask, 1995; Leask & Younie, 2001; Scrimshaw, 2001) was an appropriate approach to PBL. Holmes et al. (2001) defined this theory as "an approach to learning in which students not only construct their own knowledge (constructivism) as a result of interacting with their environment (social constructivism), but are also actively engaged in the process of constructing knowledge for their learning community" (Holmes et al., 2001, p. 1). In describing the paradigm shift from objectivist epistemologies to constructivist epistemology in distance education, Jonassen et al. (1995) explained "Constructivists engage the learners so that the knowledge they construct is not inert, but rather usable in new and different situations" (p. 10). We recognized the ongoing debate about which learning styles or strategies best contribute to success in online learning (Kauffman, 2015) and that the "majority of research does not support a statistical significant relationship between learning/cognitive styles and learning outcomes" (as cited in Holden & Westfall, 2010, p. 9). Nonetheless, we chose self-directed learning (SDL) (Knowles, 1975; Morrison, & Premkumar, 2014) and personal learning environments (PLE) (Conradie, 2014; Fiedler & Valjataga, 2011) because of the research showing that adult learners prefer these types of learning strategies (Knowles, 1975).

In addressing the first design challenge—the doctoral student body comprised of multidisciplinary aviation professionals—we needed to implement PBL in a way that was mindful of individual learning needs as well as educational and professional demands. It was important to offer students greater personal freedom in learning by taking responsibility for learning decisions and managing the course workload. Our solution was a non-linear structure, grouping the activities and assessments by SLO as opposed to a weekly schedule aligned to topics from a textbook. This meant every activity and assessment directly related to an outcome would be grouped in the same learning unit or module. The Leadership module would support achievement of SLO 1 by requiring that each student lead class research and discussion activities. The Collaboration module would support achievement of SLO 2 by requiring that the students collaborate in research and discussion activities led by the other students. The Reviews module would support achievement of SLO 3 by requiring that each student review a journal article, a peer’s draft manuscript, and a book. The Publication module would support achievement of SLO 4 by requiring that the students research and write (independently or collaboratively) a topic proposal, a draft manuscript, and final manuscript of an article for a scholarly journal. The Assessment module would support achievement of SLO 5 by requiring that each student develop final exam questions and model responses based on his or her publishable paper. Finally, the Portfolio module would support achievement of SLO 6 by requiring that each student reflect on and defend his or her achievement of the SLOs.

Although this type of grouping would be a divergence from the universal design template, the course would have the common components (e.g., learning modules, syllabus, start here area with guidance, online office, welcome discussion, resources) associated with enhanced student outcomes (Borgemenke, Holt, & Fish, 2013). We knew a non-linear UI would require different behavior from what the students were accustomed to because they would have to work on all six modules simultaneously, not sequentially. Yet, we assumed that clearly consolidating the learning activities by learning outcome would enhance each student's metacognition: higher order thinking, planning, monitoring, and evaluating progress toward achieving the outcomes.

There was an additional benefit to a non-linear structure. The discipline and management skills it necessitated would transfer to the skills required during the dissertation phase of the program. We anticipated this would help prepare a doctoral student to avoid languishing as ABD (colloquial expression for *all but dissertation*), which was important given typical attrition rates for doctoral candidates. The Council of Graduate Schools' (CGS) longitudinal study states that the 10-year Ph.D. completion rate across all broad fields of study was 57% (CGS, 2008, p. 2). Although we accepted the likelihood that not every student would embrace a non-linear structure, we believed that students would benefit from practicing the type of planning and organizational skills needed to be successful in the dissertation phase.

To address the second design challenge—no course textbook—the students would be required to find and retrieve the information they needed based on their prior knowledge and expertise (Wiggins & McTighe, 2006). Kauffman's (2015) review of the literature on predictive factors of student success lends support to this design approach. Kauffman cites a study by Ke and Zie in which online students were significantly more satisfied with an integrated course design where the "content was unstructured and adaptable; no textbook-weekly readings provided by the instructor; online discussions/team projects with active facilitation by the instructor" (para 10). In addition to course design factors, learner characteristics and skills also play a positive role in satisfaction. Students who are "self-motivated and self-directed . . . with above average executive functioning, communication, interaction and technological skills" (Kauffman, para 1.) tend to be more satisfied with online learning environments. Given the criteria used in the Ph.D. in Aviation admission process, we believe the students admitted to the program possess these skills and characteristics.

To address the third design challenge—Internet technologies carrying unforeseen usability difficulties—we needed to investigate the capabilities of the various tools available to us both within and outside of the LMS and be willing to adapt and change tools when the need arose. Not having any required weekly readings from a textbook meant that the learning technologies and tools employed in the course would need to facilitate personal knowledge discovery. Endsley and Hoffman (2002) provided the rationale for why this is important,

> But in complex sociotechnical contexts, workers do not perform tasks; they engage in knowledge-driven, context-sensitive choices from among action sequence alternatives in order to achieve goals. So, good tools must be flexible—they must provide the information that workers need to generate appropriate action sequences by which they can achieve the same goal in different situations. (p. 80)

Backward Design Stage 3

At this point in Phase 1, we turned our focus to developing the learning objectives by asking these essential questions for each outcome:

- How would the students learn what they needed to accomplish the learning outcome?
- Where would the students need to go to learn what they needed?
- How would the students know when they had met the desired learning outcome?

Given our non-linear approach to SDL, the module objectives needed to provide a learning roadmap that reflected the learning outcome, underlying beliefs, assessments, and activities for each module. Consequently, we provided a learning roadmap for each module addressing:

- What students must learn or be able to do,
- Why must they learn or do it,
- How will they know they are done, and
- Where can they go to learn it or do it.

Learning roadmaps would make it apparent right away that each student would be responsible for selecting the information to research, retrieve, and use to complete the assignments. Guidance would be provided to jumpstart and expedite their learning journey, but everything would not be pushed or doled out to them each week as is done in some conventional textbook-oriented courses.

Once we answered the larger questions, we proceeded to the myriad details of evaluating and choosing the tools for the collaborations and self-reflections, identifying and developing key resources, writing the narratives for each activity, and, finally, building the course in the LMS. Because use of information technology is a Level 6 honors skill, the students would need to use Web 2.0 tools to collaborate in the creation of knowledge. We chose both Wikispaces® and class discussion in the LMS to facilitate collaborative knowledge creation through a communal synthesis of the aviation literature in four domains: academic, industry, government, and global. These collaboration activities linked the "processes of learning and knowledge creation and publishing" (Leask & Younie, 2001, p. 128) though assimilation of broad knowledge on current practices and future trends in aviation.

We mapped the course activities to the learning outcomes and program goals and provided durations and deadlines. While the course was non-linear, it was not without structure. Indeed, as an asynchronous online course, it was quite necessary to impose structure for the

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collaboration activities and impose submission deadlines for deliverables to avoid overloading the instructor at the end of the term.

In keeping with the tenants of constructivism, the course learning environments and components provided context, construction, collaboration, and conversation (Jonassen et al., 1995). Real-world context would be provided in “settings in which the task to be learned might naturally be accomplished” (Jonassen et al., 1995, p. 12). For example, every activity and assignment supported the completion of the students’ publishable works by the end of the course. Knowledge construction was possible because each student would “make their own meaning for what they experience” (Jonassen et al., 1995, p. 12). Composing two essay items for the final exam and model answers based on their publishable contribution required them to think critically and apply knowledge in a new situation, demonstrating appropriate transfer of learning. Collaboration within each learning context would allow the students to develop, test, and evaluate their beliefs (Jonassen et al., 1995). For example, students would use the wiki collaborations to prepare a more thorough literature review for their publishable papers and would complete the scholarly reviews to learn how to evaluate the quality of published works and improve the proof editing of their manuscripts. Class conversations would mediate individual and collaborative learning. For example, each student would use the class discussions to solicit research ideas and suggestions from their classmates about their publishable paper. The metacognition required for the self-reflection in their personal portfolio would solidify their understandings from their learning experiences by connecting what they accomplished to both the course objectives and future, real-world applications.

3PD Model Phase 2: DAV 735 Implementation and Evaluation

The aim of Phase 2 was to evaluate the users' experiences (students and instructor) in situ and make improvements during the term by elaborating the narrative content and enhancing the course interface and learning environments (Irlbeck et al., 2006; Sims & Jones, 2003). This was where our approach differed again from the typical bottom-up approach of the 3PD model.

Limitations of the LMS prohibit making significant changes to an online course while it is in progress. While the premise of the 3PD approach is to make improvements during the term, revisions to the UI that would affect the grades usually have to wait until the between-term course update. For example, adding or removing graded assignments would result in an error in the final grades because of how they are calculated. Part of this limitation is also because both the creation and updating of online courses at ERAU depend on course templates.

An instructional designer creates the production template for the course in partnership with the faculty developer, the SME. Once the program chair approves this template, IDD personnel copy the production template into the master course template. Approximately 30 to 45 days before each term launch, an automated process runs that takes a snapshot of the master course template and generates the online sections of the course. For undergraduate and master's level courses, there are usually multiple sections of each course and so their 9-week terms overlap. Therefore, it is not practical to allow those instructors to make changes to their courses. Besides uninformed changes possibly having detrimental effects in course quality and functionality, it would be impossible to create and maintain a master course template that accommodated the wishes of every instructor. Consequently, when a course needs updating, the IDD team works to revise the production template, repeating the IDD production and course generation processes.

Course development within the Ph.D. in Aviation program is somewhat of an exception. Presently only one section of each online doctoral course runs at a time, usually once a year; so the 12-week terms never overlap. The same instructional designer and faculty developer/instructor are dedicated to the course throughout its life cycle. During the term, doctoral faculty can make simple changes, but they consult with the instructional designer to determine and then implement the best solutions for more complex emergent needs of the users.

For the Spring 2011 term, only one student of three enrollees completed the course: The two drops occurred early in the term due to business obligations. Obviously, collaboration and discussion activities were impossible with only one student in the course; so we made numerous accommodations during the term for this "try-out learner" (Irlbeck et al., 2006, p. 181).

Besides obtaining data from the end-of-course evaluation that the student had completed, the instructor conversed with him throughout the term, and the instructional designer interviewed him in person immediately after the term, to identify what aspects of the course he had found most helpful and why and what aspects he had found troublesome and why. Although he could not comment on the collaboration and discussion activities, the feedback he provided led to some minor enhancements for the next offering of the course.

Changes to the course for Spring 2012 only involved course familiarization and planning activities: We did not want to make any substantial changes in the UI or UX designs until the course had run with a normal compliment of students. The try-out student had said the non-liner structure overwhelmed him initially, primarily because he read everything online in one sitting. To alleviate this issue, we provided downloadable Adobe® PDF files of the web pages. This would allow the students to familiarize themselves with the course while offline. He elaborated further, saying the master course schedule, an Adobe® PDF file, was quite useful in keeping track of what he had accomplished and still had to do. We enhanced this experience by turning it into a weekly task manager created in Microsoft® Excel where each student could download it and use it to record the completion status of each assignment.

We considered the Spring 2012 offering to be in Phase 2 because it was the first time the course ran with several students. Nine of 10 enrollees successfully completed the course and one student withdrew, but only seven of nine students completed the end-of-course evaluation. Student feedback provided validation for several areas. One student was especially appreciative of the focus on preparing a journal article for publication and that the other course activities supported its development. Another student valued the diversity of the class discussions and the extent to which there was an opportunity to delve into the globalization of the aviation industry, because it had created a deep understanding of the impact of international issues and concerns on the domestic industry and regulatory processes. Student feedback revealed some UX issues with the wikis and UI issues with Wikispaces®. Some of the UX problem appeared to be from having two separate builds for each aviation domain, although this strategy was necessary to allow each student to serve as a lead or principle (research) investigator. In addition, the majority of the students were unskilled in using the different tools in Wikispaces® even though there were tutorials in the course. There was also some conflict between the wiki discussion forum in the LMS and the discussions in each wiki. The intent was for the students to use the discussion forum in the course because that would have made it easier to follow all of the postings. However, some students used the forum in the course and the discussion areas automatically available in each wiki, making tracking communications problematic for them and the instructor. Despite these issues, the result of the wiki collaborations was a 95-page monograph addressing essential questions for the future of aviation that the students took away with them at the end of the course.

The course ran twice in 2013, once during the spring and once during the fall. Three students completed the Spring 2013 course successfully and two students withdrew prior to the end of the add/drop period. Student feedback was similar to the feedback from the 2012 offering. Given the scope and depth of the issues with the wiki during the prior terms, we decided it was prudent to overhaul the activity for the Fall 2013 offering. We replaced the wiki with a collaborative literature synthesis having a much narrower scope, similar to a framework for a meta-analysis. We adopted Google Docs® for the collaboration tool and created a submission form embedded in the course that the students would use to enter curated information on a Google Docs® spreadsheet, titled *Synthesis Matrix*. We changed the focus from answering essential questions in four domains to synthesizing juried literature related to aviation issues forecast for 2025 to 2030. While this strategy would require the sacrifice of some collaboration, it would strengthen the research skills needed for their dissertation endeavors and eliminate the usability issues experienced with the wiki collaboration environment.

The instructor made some changes to the course during the Fall 2013 term to engender deeper understanding of future aviation issues and to help students prepare for the final exam. Each student was paired with another student to collaborate on writing a short issue analysis paper using relevant sources from the curated literature. A couple of students had problems finding final exam proctors and a few students asked to complete the final exam early, so the instructor elected to make the comprehensive final exam an assignment submission.

Six students completed the Fall 2013 course successfully, one student withdrew prior to the end of the add/drop period, and one student failed the course. The Fall 2013 feedback was more positive compared to that of the Spring 2013 term. Nevertheless, we found areas in the design of the UX and UI that could benefit from improvement.

3PD Model Phase 3: DAV 735 Maintenance

The focus of Phase 3 was maintenance, making fewer and smaller improvements; yet we wanted to enhance the UX, particularly the students' engagement and cognitive presence in the Fall 2014 course by fostering a better community of inquiry (Garrison, 2011) for the publishable papers. The connection between learning and emotion, as explained in the brain-targeted teaching model (Hardiman, 2010), has validated what the game industry has known for a long time: People will continue delving deeper, seeking greater accomplishments, when learning is challenging and personally engaging. We added an unstructured brainstorming discussion to run over the first three weeks of the course where students would discuss probable aviation-related problems forecast for 2030 and their ideas, no matter how farfetched, for possible solutions. We also added a student-led discussion that focused on issues selected from the Synthesis Matrix. Each student would lead, or co-lead—depending on the number of students in the course—a class discussion on an issue relevant to the future of aviation and to the topic of his or her publishable paper. In addition to these enhancements to the UX, the UI needed some improvements as well.

The hyperlinks to external course resources were problematic to maintain, because they would break when their host websites underwent redesign or revision, oftentimes not long after we had verified the hyperlinks were working. To ameliorate this, we created the DAV 735 Research Guide, a sub-site of the university library website, consolidating virtually all of relevant external resources including books, articles, databases, and videos. The research librarian would maintain the site and add or remove resources when we asked. We included the hyperlink to this library guide in the course menu for quick access, and we instructed the students to begin there to facilitate their research endeavors. Additionally, the instructional designer redesigned the UI so that it would not take more than two computer mouse clicks to reach any content from the course menu in the LMS. Avoiding deep linking in the course would save the students' time when accessing information, and it would save us time when checking the operability of the course each term.

There were 13 enrollees in the Fall 2014 term, precipitating the instructor to make several changes to the course during the term to ease student workload while ensuring academic rigor. The requirement of 10 unique contributions per student to the Synthesis Matrix would have produced 130 annotated articles, too many for the students to digest for a five-page analysis. Therefore, the instructor reduced the number to five. To confirm rigor and quality of the students' publishable papers, the instructor required that the students obtain final approval before they submitted their works to the publishers. This also helped ensure acceptance for publishing.

Twelve students completed the Fall 2014 course successfully and one student withdrew prior to the end of the add/drop period. Student feedback was more positive compared to the Spring 2013 term. The brainstorming discussion had created a stronger cognitive presence in the course, as evidenced in 222 posts covering innovative ideas. Students transitioned successfully from their initial inquiries related to a future aviation problem to the eventual construction of knowledge in their publishable papers by focusing on a viable solution to their selected problem. The shared goal of contributing to a systematic review of the relevant aviation literature on the Synthesis Matrix created an e-learning environment that promoted cooperative knowledge discovery, acquisition, and dissemination. In the Student-led Discussions, the leads demonstrated communication, negotiation, and consensus-building skills needed by principal investigators. Non-moderating participants demonstrated communication and cooperation skills needed by research collaborators. The success of these constructivist strategies have been demonstrated by DAV 735 students publishing scholarly works on topics such as aviation safety issues, supersonic flight, cockpit electronics, unmanned aerial systems, airport security, and the economics of modernization programs in peer-reviewed journals on three continents.

As part of ERAU's continuous improvement process, each student has the opportunity to complete an anonymous survey at the end of every course. The instrument consists of three open-ended items and 17 forced-response items that use a standard 5-point Likert scale ranging from 1 (*low*) to 5 (*high*) to rank the degree of agreement with the statement. The results become available to instructors after the term has ended.

The significant changes made to the course after the Spring 2013 term likely led to more positive student feedback from the Fall 2014 term. The 2014 survey results for the dimensions of interest in this case analysis reflected favorable improvements as shown in Table 5 even though there was one extremely negative outlier on all items except the UI and Workload items. There was a slight reduction in student workload in 2014, dropping from 10 to 15 hours/week to less than 10 to 15 hours/week, and the course UX item represented the largest change from 2013.

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Table 5

Central Tendencies for Course User Interface (UI), Course Experience (UX), Instructor Experience (UX), Satisfaction, and Workload

	Spring 2013 (n = 3)			Fall 2014 (n = 11)		
	M	*SD*	*Mdn*	*M*	*SD*	*Mdn*
Course UI	3.33	2.08	4.00	4.09	0.83	4.00
Course UX	2.33	1.53	2.00	4.09	1.38	5.00
Instructor UX	3.33	1.53	3.00	4.36	1.21	5.00
Satisfaction	3.00	2.83	3.00	4.09	1.30	5.00
Workload	4.33	0.58	4.00	3.73	1.10	4.00

Note. All values represent raw, non-standardized scores. The response rates were 100% and 92% for the Spring 2013 and Fall 2014 terms, respectively. The course UI item = "My overall impression of this delivery mode is positive." The course UX item = "Instructions for the course activities and assignments were clear." The instructor UX item = "My overall impression of the instructor is positive." The satisfaction item = "How likely is it that you will recommend this course to another student?" The workload item = "The average amount of hours I spend working on this course (in and out of class) per week is [*hours per week*]."

Qualitative feedback also lent support to the redesign aspects of the collaboration activity. For example, one student stated, "The course was tough and at the same time, immensely rewarding. I really enjoyed the 'no textbook' approach that encouraged us to pursue current literature." Commentary provided in the self-reflections, in which students defended their achievement of the course objectives and explained how their learning would transfer to other endeavors, revealed that the Synthesis Matrix, as a tool, was going to be very helpful during their dissertation research.

The overall positive results led us to submit the course to the Blackboard® Exemplary Course program, an annual worldwide competition spanning education at every grade level and every academic domain for blended and online courses that use the Blackboard® Learn LMS. After undergoing the rigorous multi-level review process—multiple blind peer reviews and jury evaluations—DAV 735 won a Blackboard® Catalyst Exemplary Course award in 2014. This recognition was external validation of our course design and continuous improvement process.

Conclusions and Recommendations

This case study of DAV 735 demonstrates the necessity of an agile, iterative, and collaborative course design and improvement process. This is apparent in the type and number of changes we made to the course activities over the span of five years as summarized in Table 6.

Table 6

Course Activities and Assessments by Term

Modules	Spring 2011	Spring 2012	Spring 2013	Fall 2013	Fall 2014
Leadership	*Module forums; *Student-led wiki forums	Module forums; *Student-led wiki forums	Module forums; Student-led wiki forum	Module forums; *Student-led forum	Journal Article forum; Student-led issue forum
Collaboration	*Wikis; *Leadership summary & surveys	*Wikis; *Leadership summary & surveys	Wikis: Discussions; Leadership summary & surveys	Literature synthesis: Google Docs®; *Issue analysis	*Literature synthesis: Google Docs®; Issue analysis
Reviews	2 Journals, Book/report, *Peer's draft	2 Journals, Book/report, *Peer's draft	2 Journals, Book/report, Peer's draft	2 Journals, Book/report, Peer's draft	1 Journal, Book/report, Peer's draft
Publication	Journal article; Updates	Journal article; Updates	Journal article; Updates	Journal article; Updates	*Journal article; Updates
Assessment	*Exam items & answers; Proctored exam	*Exam items & answers; Proctored exam	Exam items & answers; Proctored exam	Exam items & answers; *Final exam	Exam items & answers; Final exam
Portfolio	Artifacts; Reflection	Artifacts; Reflection	Artifacts; Reflection	Artifacts; Reflection	Artifacts; Reflection

Note. * denotes changes affecting user experience made by the instructor during the term.

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Rivest (as cited in Menezes, van Oorschot, & Vanstone, 1996-2001) eloquently states the corollary between theory and practice: “Theoretical work refines and improves the practice, while the practice challenges and inspires the theoretical work. When a system is ‘broken,’ our knowledge improves, and next year’s system is improved to repair the defect” (Foreword, para 2). We find this to be true in our experience as the BD model we deployed within the 3PD model was a successful approach in addressing wicked instructional design challenges of an online doctoral course. The main advantages of this approach are relatively rapid course development and responsive improvement informed by the emergent needs and experiences of the users. A small production partnership of one instructional/graphic designer and faculty developer/instructor, indicative of the Ph.D. in Aviation program at ERAU, can apply this process efficiently and cost effectively owing to their dual roles and shared understandings of the challenges, goals, and objectives. While we believe this is essential in meeting demands for quality by other users, programs, and universities in the fast-moving field of online education, we concede that it might be difficult to implement the 3PD model over the span of multiple offerings of a course in the absence of a long-term professional collaboration between the instructional designer and faculty developer.

Given our experience putting theory into practice, we plan to continue using the 3PD framework to continue improving the course, because even small changes when compounded can have meaningful impacts on learning. Based on what we have learned from applying the BD and 3PD models, we have two recommendations to inform future practices of IDD teams tasked with challenging online doctoral courses:

- Use an iterative and collaborative approach to course development and to implementing improvements in UI design and UX design.

- Deploy problem-based learning and learner-centric communal strategies and tools that empower doctoral students to make learning choices that define their personal learning paths and enhance their learning environments.

As a reflective model dependent on student perceptions and experiences, adapting the 3PD model by embedding the BD model within Phase 1 and conducting the course evaluation, elaboration, and enhancement across Phases 2 and 3 suggests that both models might need to be either extended or elaborated. However, our analysis had several limitations, raising several questions for further investigation. The limitations of using a LMS template-based production process and lack of generalizability due to small sample sizes (low student enrollments or feedback) may necessitate delaying transitioning from one phase to the next within the 3PD model. In addition, because DAV 735 is the only course in the program that does not rely on a textbook and has a non-linear module structure, prior education experiences may bias the students' opinions. Therefore, we recommend future research focusing on comparative analysis to quantify the results of using our modified approach as an instructional design framework for asynchronous, online doctoral courses. We also recommend examining the applicability of these models across other types of online learning environments and by different IDD teams in higher education.

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