Guidelines for curriculum and course development in higher education and training

Rochelle E. Tractenberg¹, Jessica M. Lindvall², Teresa K. Attwood³, Allegra Via⁴

1. Collaborative for Research on Outcomes and –Metrics; and Departments of Neurology; Biostatistics, Biomathematics and Bioinformatics; and Rehabilitation Medicine, Georgetown University, Washington, DC.
2. National Bioinformatics Infrastructure Sweden (NBIS), Science for Life Laboratory (SciLifeLab); Department of Biochemistry and Biophysics, Stockholm University, S-10691, Stockholm, Sweden.
3. Department of Computer Science, The University of Manchester, Manchester, UK
4. National Research Council of Italy, Institute of Molecular Biology and Pathology, Rome, Italy.

Reprint requests:

Rochelle Tractenberg
Neurology Department, Building D, Suite 207
Georgetown University Medical Center
4000 Reservoir Rd. NW
Washington, DC 20057 USA
rochelle.tractenberg@gmail.com

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Running Head: Curriculum and Instruction Development Guidelines

Abstract

Curriculum development in higher education should follow a formal process. Although the focus in formal curriculum theory is on long-term programs of study, the theoretical and practical considerations are also applicable to shorter-form learning experiences (single courses, lessons, or training sessions). With these considerations in mind, we discuss here an iterative model of curriculum design, the starting point of which (indeed, *in the construction of any learning experience*), is the articulation of the target learning outcomes: everything follows from these, including the selection of learning experiences and content, the development of assessments, and evaluation of the resulting curriculum. We discuss how the iterative process can be used in curriculum and instructional development, and provide a set of practical guidelines for curriculum and course preparation.

Introduction

Curriculum is defined as the “inventory of activities related to the design, organisation and planning of an education or training action, including definition of learning objectives, content, methods (including assessment) and material, as well as arrangements for training teachers and trainers”¹. The time-frame for curriculum delivery can range from a sequence of courses to a program leading to a certificate or degree. UNESCO^{2,3} specifies four curriculum types:

1. *Intended* curriculum: formal specification of the Knowledge, Skills and Abilities (KSAs) that students are expected to achieve, and be able to demonstrate (also called the *official* or *planned* curriculum);
2. *Implemented* curriculum: how the intended curriculum is translated into/delivered in practice: i.e., the teaching and learning activities, including interactions between learners and teachers, and among learners (also called the *curriculum in action* or the *taught curriculum*);
3. *Attained* curriculum: what learners actually acquire, and can demonstrate, having followed the implemented curriculum;
4. *Hidden* curriculum: contextual, typically unintentional, effects of a curriculum – social, cultural and even disciplinary norms and KSAs that are transmitted to learners with some consistency, but without alignment with the stated Learning Outcomes (LOs)⁴. This lack of alignment makes the hidden curriculum and its effects difficult to assess or evaluate (also described as *school-related factors*).

Recognizing these diverse types of curriculum is important because, while the *intended* curriculum is the starting point, it may not be the curriculum actually *attained*. Identifying whether there are substantive or extensive differences between the intended and attained curricula (i.e., via actionable evaluation) allows improvements to be made; ideally, the differences should be minimal. In addition, to be considered *successful*, a curriculum should:

- a. include opportunities for assessment that enable learners to demonstrate their progress in authentic, interpretable ways. Learners and independent observers should both be able to judge whether the curriculum is achieving what was intended (Bresiani, 2006, p. 14; Devine et al., 2007, pp. 51-52);
- b. provide explicitly for the evaluation of the functioning of the curriculum itself (Fink, 2013; Hutchings et al., 2015; Hutchings, 2016), in order to determine the extent to which it has accomplished its stated goals (Marzano, 2001, p. 2) and LOs; and
- c. include assessments that provide actionable evidence (National Institute for Learning Outcomes Assessment (NILOA), 2016)) for learners and instructors, allowing valid – justifiable and defensible – decisions to be made about learners (Messick, 1989, p. 13).

The *attained* curriculum can only be ascertained by determining what learning actually occurred: this is a function of the curriculum’s goals and LOs, and the assessment of whether these were achieved – i.e., understanding what makes a curriculum *successful* is contingent on LOs and assessment; these will only be recognized/recognizable when the curriculum is evaluated.

¹ Terminology of European education and training policy. 2nd ed. Luxembourg: Publications Office of the European Union, 2014. DOI: 10.2801/15877

² UNESCO International Institute for Educational Planning: <https://learningportal.iiep.unesco.org/en/glossary>

³ UNESCO defines a curriculum as a collection of “activities related to the design, organisation and planning of an education or training action, including definition of learning outcomes, content, methods (including assessment) and material, as well as arrangements for training teachers and trainers.”

⁴ Learning Outcomes are statements describing what learners will be able to do, and demonstrate, by the end of instruction.

In general, for a given program, the curriculum should specify the KSAs – expressed in the LOs – that are proposed to be achieved; how learners will demonstrate their achievement; the lessons and/or assignments the instructors will use to support learner progression towards the LOs; the materials to be used; and the assessments for evaluating student learning⁵. Historically, curriculum design for primary- and secondary-school education has been driven by the LOs of interest (e.g., Tyler, 1949), an approach described as *backward design* (Wiggins & McTighe, 1998; 2005). However, curricula in higher education do not typically follow this formal approach (Roksa et al., 2016, pp. 25-26); rather, their design tends to be informal – i.e., they are generally developed around available personnel and their expertise, and the content (or competences) considered essential to graduates' (and the programs') credibility.

The key features of formal curriculum development include its general context (defining stakeholders, potential professions, desired performance and/or competences of course completers, etc. (El Sawi, 1996; Diamond, 2008)), duration, composition and content, emphasizing both teaching (to ensure that this is consistent across the curriculum) *and* learning (to ensure that this is accomplished), and mechanisms for collecting evidence that learners have changed over time. These are essential features of an effective curriculum (i.e., one that achieves its stated LOs for the majority of learners); they are also important for effective instructional design on shorter time-scales. This paper is intended to support the design of successful curricula and instruction, and to offer practical guidance for devising and evaluating both short- and long-form teaching. This can inform higher-education curriculum developers; it can help instructors in developing their own courses and those who may lecture within a course (or other fixed instructional or curricular contexts); it can also help individual learners to identify the most appropriate learning opportunities for their goals and objectives.

Formal structure for curriculum development

The design of curriculum or instruction should be formal and systematic (El Sawi, 1996; Diamond, 2008; Fink, 2013; Nilson, 2016). Once the purpose and context of a curriculum has been determined, the design process can begin, including its content, assessment and evaluation mechanisms, which will determine its composition and duration. One useful paradigm for guiding this process was proposed by Nicholls (2002), who described five phases in curriculum design:

1. Select or identify LOs;
2. Select or develop learning experiences that will help students achieve the LOs;
3. Select or identify content that is relevant to LOs;
4. Identify or develop assessments to ensure learner is progressing towards LOs;
5. Evaluate the effectiveness of the learning experiences for leading learners to the LOs.

Critically, Nicholls characterizes these as *phases*, underscoring that each is a *process* (see also El Sawi, 1996). Diamond (2008) outlines the complexities of this process, emphasizing the need for focus at each phase; his book provides worksheets to support instructors and administrators through the process.

Before engaging with Nicholl's five design phases, two key aspects of teaching and learning should be understood: i) Bloom's taxonomy and ii) Messick's assessment criteria.

i) Bloom's taxonomy of cognitive complexity

A model describing cognitive complexity in learning processes was proposed by Bloom in 1956 (Bloom, 1956). The model introduced a six-level hierarchy, ranging from "Remember" (relating to the ability to recall information) to "Evaluate" (concerning the ability to make and defend judgments, or assess theories and outcomes) – see Figure 1. The levels are hierarchical in the sense that learners need to have demonstrated achievement of *prior* Bloom's levels before advancing to more complex ones. The taxonomy thereby introduces a *developmental trajectory* in

⁵ The glossary of Education Reform: <https://www.edglossary.org/curriculum/>

learning; this can guide the articulation of coherent LOs by helping to identify the most appropriate (measurable, active) verbs that express expected behaviors of individuals at the corresponding Bloom's level. For example, achieving the level *Understand* means to be able to classify, select or explain a given piece of information: here, the verbs *classify*, *select* and *explain* are concrete, observable and assessable.

Evaluate Make & defend judgements, assess theories & outcomes	EVALUATION Critique, compare ideas, solve, recommend, rate	Higher-order 'critical' thinking skills
Synthesise Pull ideas into a coherent whole, create new ideas	SYNTHESIS Combine, formulate, illustrate, imagine, design, invent, compose	
Analyse Resolve ideas into simple parts, identify patterns	ANALYSIS Calculate, examine, model, test, break down, infer, predict, test, solve	
Apply Apply knowledge to real situations	APPLICATION Operate, manipulate, choose, experiment, modify, prepare, produce	Lower-order thinking skills
Understand Demonstrate understanding of facts	COMPREHENSION Distinguish, classify, select, review, discuss, indicate, explain, estimate, locate, summarise	
Remember Recall/reiterate information	KNOWLEDGE Memorise, recognise, identify, describe, reproduce, list, define, label, name, state, outline, order, arrange	

Figure 1. Bloom's taxonomy of cognitive complexity, and associated verbs that can be used to create LOs. The verbs reflect a developmental trajectory, from lower- to higher-order thinking skills; they should be concrete and observable, and relate to how instructors will assess achievement of target LOs.

There are numerous freely available resources that provide lists of Bloom's verbs like those shown in Figure 1. While El Sawi, Nicholls and Diamond focus on the *process* of curriculum development, the key cognitive aspects embodied in the LOs are also important; these are usually in the control of the instructor. Instruction should aim to promote more complex cognitive behavior than just *recall* or *recognition* (unless memorization of facts is the intended LO (Ambrose et al., 2010; Nilson, 2016; Weinstein & Sumeracki, 2019)), and push learners to achieve greater cognitive complexity. This can be done by embedding *development* within teaching, activities and materials, or by ensuring that the learning promoted by the LOs will be foundational for ongoing learning beyond the end of a course (Knapper, 2006; Roediger & Karpicke, 2006; Jensen et al., 2014) – or some combination of these strategies.

ii) Messick's criteria for valid assessment

In 1994, Messick outlined core criteria for assessment validity (Messick, 1994), which can be formulated as three questions:

1. What are the KSAs that learners should possess at the end of the curriculum?
2. What actions or behaviors by learners will reveal these KSAs?
3. What tasks will elicit these specific actions or behaviors?

These support all phases of curriculum development, and are particularly helpful in selecting KSAs and LOs.

Regardless of the particular framework you choose, *using a formal paradigm will facilitate the development of a curriculum, or of any instructional endeavor, by leveraging what is already known about education and learning, and providing structure for decision-making.*

A. Identify and follow a formal paradigm for curriculum or instructional design.

Nicholl's five phases of curriculum design

By way of exemplar, we use Nicholls' paradigm for curriculum design, illustrated in Figure 2. Within this framework, each phase shows clear dependencies; all are ultimately dependent on the first – defining LOs.

Figure 2. Nicholls' five phases of curriculum design and their dependencies. For each phase (rectangles), the key questions that should be asked are shown (diamonds). Where questions haven't been satisfied, that phase or previous phases or the LOs should be revisited (red arrows); once they have been satisfied, this feeds forward into the next phase(s) (green arrows). When all questions are satisfied, the curriculum or instruction can be characterized, with concrete evidence, as *successful* (star).

As can be seen, the phases are iterative rather than strictly linear – in other words, the LOs influence later decisions, but later decisions may also reflect development/revision of the curriculum back to those LOs. This iterative process hence provides opportunities to check for alignment (assurance) of each phase to the LOs, whose role is therefore pivotal. The LOs are identified in Phase 1; they must have specific characteristics to function, and support each of the other phases as they do.

Figure 2 illuminates a striking feature of the process: that LOs, not the content, are the starting point, driving all decision-making. This is true for formal and informal, short- and long-term instruction (Diamond, 2008). Given the essential role of LOs for effective curriculum design, it is perhaps surprising that what is missing from Nicholls' discussion of the design phases (and from much of the discussion of curriculum design in higher and post-secondary education) is the dependence of LOs on a hierarchy of cognitive complexity that establishes a *developmental trajectory*, such as seen in Bloom's taxonomy (Bloom, 1956). This crucial point, and the five phases themselves, are discussed in the sections that follow.

Phase 1: Define intended learning outcomes

Identifying or crafting LOs is the first phase in curriculum design. Focusing on LOs first is essential to ensure that all later decisions contribute to a coherent and realistic curriculum; this is true even if the curriculum already exists and decisions are being made at any subsequent phase. However,

LOs are notoriously difficult to write. To give an idea of how to articulate LOs in practice, it can be helpful to use structured sentences like, “*At the end of instruction, learners should/will be able to [measurable action verb]⁶ [content term(s)]*”: e.g., “*At the end of instruction, learners will be able to [illustrate] [Newton’s third law of motion]*”. Notice that the “*ability to illustrate Newton’s third law*” is, in principle, assessable (e.g., using an open-ended question). By contrast, verbs open to several interpretations (*know, learn, understand*, etc.), should be avoided: e.g., a LO like, “*At the end of instruction, learners will **know** Newton’s third law*” may have different meanings to different people: will learners be able to describe, explain, apply, analyze, summarize or evaluate Newton’s third law? What does it mean to *know* it? How will *knowledge* of the law be demonstrated? By what test would an instructor assess that knowledge?

Similarly, terms like *satisfactorily* or *proficiently* shouldn’t be used in the articulation of LOs, unless they’re defined *a priori*, and are both realistic, given learner starting points, and specific. For example, a LO such as, “*At the end of instruction, learners will be able to apply Newton’s third law **satisfactorily***” requires a definition of *satisfactorily* before achievement of this LO can be determined. Also, what is satisfactory to the learner may not be satisfactory to the instructor, or to an independent evaluator of the course or curriculum (such as an accrediting body).

It can be seen, then, that a particular challenge in writing LOs is in the choice of appropriate verbs. Indeed, the verbs should not only express measurable, observable and assessable actions, but should also accurately describe what – *and at what level of cognitive complexity* – successful learners will be able to do by the end of instruction. The following list of LO characteristics are from Stanford University⁷; their detail and complexity may explain why it feels easier to begin with the content (Phase 3) rather than the purpose of learning (LOs):

- *LOs should be specific and well defined.* LOs should clearly and concisely describe the specific KSAs that learners should develop, and be able to demonstrate, as a result of instruction. Vitally important here is the fact that LOs support the identification or design of assessments that can differentiate successful demonstrations of LOs from those that are not, both with consistency across performers at one time, and within performers over time. If this is not possible for all performances, then the LO may not be sufficiently well defined or specific. LOs drive all curriculum-development decisions: committing to the development of well-defined, observable, consistently evaluable LOs will thus facilitate work in later phases of the development process.
- *LOs should be realistic.* LOs must be attainable, and consistent with learners’ abilities, developmental levels, prerequisite KSAs, and the time needed vs. time available to achieve them. They must also be realistic given the context and resources available for instruction (Phase 2): e.g., it is not realistic to set LOs involving critical thinking in courses where the material is delivered entirely via lectures and tested using multiple-choice exams. Overall, LOs should be articulated so that target performance levels are reasonable, given the available time, instructional resources, and the requisite preparation of learners.
- *LOs should rely on active verbs, phrased in the future tense.* LOs should be stated in the future tense in terms of what successful learners *will be able to do as a result of instruction*; they need to be active and observable so that their accomplishment can be assessed. Figure 1 gives examples of active verbs as they relate to Bloom’s taxonomy.
- *LOs should focus on learning products, not the learning process.* As noted, LOs should state what learners will be able to do (as result of instruction), not what instructors will do during instruction; hence, they shouldn’t be stated in terms like, “*Introduces Newton’s third law*” – introducing material is what the instructor will do; it isn’t an outcome of learning.

⁷ The Stanford University Office of Institutional Research and Decision Support
<https://irds.stanford.edu/sites/g/files/sbiybj10071/f/clo.pdf>

- *LOs should be simple, not compound.* LOs shouldn't include compound statements that join two or more observable, specific behaviors or KSAs into one statement: e.g., a LO like, "*Learners will be able to explore, prepare, analyze, visualize, and interpret big data,*" bundles five LOs together (exploring, preparing, analyzing, etc.); learners would need to be able to demonstrate all of them for this LO to be considered achieved. This would be problematic in any program, and virtually impossible for short-form training. Irrespective of the time-frame and reality of accomplishing such high-level LOs in any course or curriculum, bundling complex behaviors together creates difficulties in terms of instruction, and means that no learner can achieve the LO without achieving *all parts* of it.

Other considerations for drafting LOs include:

- *LOs should be framed in terms of the program, not specific classes the program offers.* Clearly, this relates to programs rather than individual courses; what is important here is the alignment of LOs with the overall program or curriculum goals. Alignment with any larger-scale considerations of growth, performance or development should also be considered⁸. *If there is no such coherence*, it suggests that the program design should be revisited, starting with reformulation of its LOs.
- *LOs should be appropriate in number.* It is important to ensure that LOs represent an achievable and meaningful result for the investment of time and effort by the learner, whether this be a program or a short course. The period of instruction should also provide sufficient time to be able to deliver and assess those LOs.

In addition to these considerations, NILOA (2016) published five principles for articulating LOs in higher education: namely, that they should be

- specific and actionable;
- connected with learner work;
- derived collaboratively (*across disciplines*);
- supportive of assessment that generates *actionable* evidence; and
- focused on improvement.

Here, *actionable* means supportive of a decision, or the taking of some action by a learner, instructor or institution; there are many freely available resources that offer guidance on LO articulation, including those discussed above. In some cases, the LOs may have been fixed by others, or have been approved and cannot be modified; in other cases, the LOs may be inconsistent with the time or instructional resources available. In either of these cases, ensuring that the target LOs meet the NILOA (2016) characteristics, or are consistent with the Stanford criteria, can enable discussions with those who are in a position to make appropriate changes to bring the curriculum into better alignment with the LOs. Ultimately, *LOs provide the necessary structure and context for decision-making by instructors and learners, hence their primary role in curriculum and instructional design.*

B. Focus on LOs first to inform all other decisions about the curriculum and instruction.

Phase 2. Select learning experiences that will lead to the LOs

Phase 2 involves identifying Learning Experiences (LEs) (lectures, webinars, solving problems, work in groups, peer instruction, flipped classrooms, etc.) that would, if a learner completed them, lead to the LOs. This is an example of how defining LOs directs the decisions that are made throughout the curriculum- and instructional-development process: LOs help instructors to choose the most appropriate LEs for supporting learners to achieve desired LOs. If LOs include *demonstration*, then the LEs must be consistent with learner abilities to *demonstrate* what they've

⁸ This will help learners better understand how they will benefit from the larger program or plan, consistent with what is known about adult learning (e.g., Knowles et al., 2006; Ambrose et al., 2010).

learned – i.e., LEs and LOs must be aligned. Misalignment of LOs and LEs can lead directly to a gap between the intended and actual curricula, which is one reason why curriculum/instructional evaluation (to detect such misalignment) is so crucial.

There are many different LEs, and each can lead or permit learners to demonstrate different Bloom's-level accomplishments: e.g., hearing information (lecture) is different from working with information (exercises), just as following directions (e.g., to complete a lab exercise) is different from creating something new (e.g., writing a computer program). Sometimes, it may be necessary to embed specific LEs in a curriculum without considering the LOs they serve *a priori*. For example, if lectures or pre-recorded materials form the foundation of a course, it may not be possible to choose alternatives that are more likely to lead to the specified LOs. However, even where LEs are fixed, LOs are still the most important feature to consider. If your LE is fixed, then the LO must be modified to be consistent with it; but if your LOs are fixed, then you can choose, vary, or add LEs that will support the achievement of the LOs. Drafting or revising LOs can be driven by a fixed or desired LE: *the key is to determine exactly what the specific LE can contribute to learning or how it will help move learners towards the LOs.*

B1. Leverage LOs to explore and identify appropriate LEs.

Phase 3. Select content relevant to the accomplishment of LOs

Finding content that can be featured in the LEs is Phase 3, not Phase 1, of the process. Content can be obtained from diverse areas of a discipline, or even from diverse disciplines, to strengthen the likelihood of achieving the target LOs. However, content selection should be judicious: it should include only material that is likely to support achievement of the specific LOs and not try to be all-encompassing (Nilson, 2016, p. 30). Once appropriate *core* content has been identified, other content that does not have a clear rationale in terms of promoting LOs can be offered as *auxiliary* material (e.g., as suggested reading for learners to find additional information). Hence, using LOs to drive content selection is important, because it both enables instructional focus, so that too much is not squeezed into a course in order to ensure *coverage* (e.g., McKeachie, 1994; Lujan & DiCarlo, 2006), and increases the likelihood of accomplishing those LOs.

Sometimes, specific content may have been identified as essential to a particular course or curriculum (e.g., DeVeaux et al., 2017). If content is, or seems, fixed, it can be difficult to make the shift from content- to LO-driven decisions. In this case, Messick and Bloom's can be used to make adjustments so that what it means to *learn that content* or what it looks like to have *learned that content* can be made concrete and observable. If such fixed content does not lead to observable behaviors that are, or support the achievement of, LOs, then additional content should be considered that will; otherwise, it may be necessary to discuss the feasibility of modifying the content or revising the LOs with those who are able to make changes, to avoid misalignment of intended and actual curricula.

Overall, there is considerable scope for promoting the accomplishment of the LOs by thoughtful selection of relevant content, which should include consideration of both the target Bloom's levels in the LOs, and the prerequisite preparation of learners. *LOs help to focus on relevant content, and to avoid material that is either non-essential/too broad or too narrow.*

B2. Leverage LOs to select content that is appropriate for the LEs and promotes the achievement of the LOs.

Phase 4. Develop assessments to ensure learner progression

In a successful curriculum, learners must be given opportunities to demonstrate that they're progressing; these opportunities are the curriculum's built-in assessments (tests, evaluations, feedback collection, measurements or other documentation of learning progress, skill acquisition,

etc.). Fundamental to the process outlined in Nicholls' model is the inclusion of *two different types* of assessment: specifically,

- i) to evaluate *learning* – i.e., formative assessment to detect changes in learners' performance as a result of instruction, to characterize their strengths, and identify (*diagnose*) their weaknesses (formative results can help make decisions about how to modify instruction (including self-directed instruction) to promote learning); and
- ii) to evaluate *the effectiveness of the instruction* – i.e., summative assessment to determine whether the LOs have been achieved (summative results help to make decisions about learners (e.g., ranking performances, setting pass/fail points)).

Both formative and summative assessments (evaluating learning during and after instruction, respectively; Walvoord, 2010) are useful; however, it should be recognized that, because summative assessments are administered *after* instruction, they do not always provide important information about learners' *progress through it*. It may be difficult to conceptualize how to integrate formative assessments into a given lesson or LE; however, these need not be complex or time consuming – just informative about learning at the particular juncture of the instruction. Formative assessments that encourage learners to consider explicitly what they do and do not know, or are/are not confident about, can help focus attention on developing metacognition (knowledge of one's own thinking) and the ability to self-assess (Ambrose et al., 2010, pp. 188-216)⁹. Simple examples of metacognitively-challenging assessments include:

- *reflection*: towards the end of class, ask learners to reflect on the lesson and write down what they've learned. Invite them to consider how they'd apply this new concept or skill in a practical setting;
- *hand signals*: these can be used to gauge learners' confidence with content using agreed signals, ranging from maximum to minimal confidence. This engages all learners, and allows instructors to check their confidence with content, even within large groups;
- *3-2-1*: at the end of a lesson, ask learners to note 3 things they learned from the lesson; 2 things they want to know more about; and 1 question they have. This stimulates reflection on the lesson, and helps to process their learning;
- *misconception check*: present some common or predictable misconceptions about a concept being covered. Ask learners whether they agree/disagree, and to explain why¹⁰;
- *diagnostic questions/questionnaires (which may be anonymous)*: ask learners to note one thing they didn't understand or that they missed, and one thing that was very clear to them.

These, and many other formative-assessment options, can be found online.

If formative assessments are deployed frequently, and in a way that leads to specific decisions by learners and instructors, then instruction (or preparation by learners) can be modified to better develop the target LOs (William et al., 2008; Wiggins & McTighe, 1998; Trumbull & Lash, 2013: p. 9). Formative assessment can be designed to anticipate – and identify which learners are experiencing – common misunderstandings, and gauge readiness to move ahead. These features can be leveraged to engage learners in metacognitive activities that help learners to identify their own strengths and weaknesses. Suggestions for how learners can address any weaknesses or misunderstandings they've discovered, or for further/deeper learning, can also be built into assessments (e.g., "*if you chose option C, you might want to re-read chapter 1*"); formative assessments can therefore also support *self-instruction*.

⁹ Although the literature base documenting empirical evidence of the importance of formative assessment in adult learning is limited (see Dunn & Mulvenon, 2009, for review of the literature about formative assessment in children's education), the development of metacognition is critical (see, e.g., NRC 2001; Ambrose et al. 2010 Chapter 7).

¹⁰ These suggestions came from Saga Briggs (*20 Simple Assessment Strategies you can use every day*, <https://www.teachthought.com/pedagogy/20-simple-assessment-strategies-can-use-every-day/>)

By contrast, summative assessment, being primarily descriptive, is not diagnostic of weaknesses in learners' understanding, nor does it lead directly to changes in instruction that will remediate them. It is therefore neither actionable for learners, nor directly actionable for instructors (because instruction has ended). However, a summative assessment may lead *indirectly* to changes in instruction if, for example, the results suggest uniformly low levels of learning occurred. Instructors may then choose to revisit the LE(s) for later editions of the course to ensure that both the LE(s) and the assessments are aligned with LOs. Of course, uniformly low levels of learning could also suggest that the assessments need to change, rather than necessitating any changes to the instruction itself. Before using summative results in program evaluation (Phase 5), instructors should ensure that performance actually reflects student learning levels rather than properties of the assessment instrument itself (like poorly worded questions, or ambiguous response options). At the end of a period of instruction, it may be tempting to use learners' completion of, or satisfaction with, the instruction as metrics of success. Completion rates and satisfaction ratings are, of course, simple outcomes to collate, but they are not informative about either learners' growth, or a curriculum's functioning¹¹ (Roska et al., 2016). Satisfaction ratings and completion rates are not consistent with any of the NILOA or Stanford criteria for LOs. Adding actionable formative assessment during instruction, and considering what actions a learner, instructor or institution can actually make based on summative assessment, can help ensure that the LOs – and progress towards them – are explicitly supported by those assessments.

Assessment should provide evidence that a learner has achieved, or is making progress *towards learning outcomes*; summative assessments are descriptive for curricular and instructional outcomes while formative ones describe progress within a course or lesson; the latter is particularly important in instruction where summative assessment is more difficult (e.g., short-form training). In both curricula and short-form instruction, *LOs clarify what specifically needs to be assessed and why*.

B3. Assess learning based on achievement of LOs using formative and summative assessment, as appropriate.

Phase 5. Evaluate effectiveness of the curriculum/instruction

The final step in developing a curriculum or instructional opportunity is to plan, and complete, an *actionable evaluation*. This involves collecting (qualitative and quantitative) data about the program or course - including summative assessments - to determine its quality or effectiveness, with the aim of deciding whether to adopt, reject or revise any of its specific features (Worthen & Sanders, 1987). Curriculum effectiveness is defined in terms of the success of the *implemented* curriculum in leading learners to the outcomes articulated in Phase 1: in other words, it is a measure of how well the *attained* curriculum is aligned with the *intended* curricular objectives. In the absence of such alignment, programs or courses cannot be characterized as either *successful* or *effective*. Given the work that Phases 1-4 necessitate, evaluating your curriculum or instruction is essential: an *actionable* evaluation will lead to concrete decisions: it will not simply describe successes, but will identify weaknesses that need to be remediated.

Ultimately, there should be a plan, including a set of outcomes, for curriculum evaluation. Formulating this plan requires time and attention; its execution will likely require resources (possibly including an independent evaluator). The most important aspect of this phase is that there must be a *plan* to evaluate, to determine which parts are supporting closer alignment between *intended* and *actual* curricula, and to identify aspects that undermine or simply do not support this alignment. Some curriculum developers may plan only to document *successes*, without considering which features led to success and which did not – this is not actionable

¹¹ There are many free/open-source resources that can facilitate the development and evaluation of assessments for lessons, courses and curricula (e.g., the Measuring College Learning Project, <https://www.ssrc.org/programs/component/education-research-program/measuring-college-learning/>)

evaluation. If a planned evaluation cannot provide actionable information, instructors will need to develop their own (if these generate actionable results, it is advisable to share them with curriculum developers or other instructors and stakeholders as evidence that actionable evaluation is possible). *Ultimately, the evaluation should identify what works, and what needs remediation, in the instruction or curriculum to better support the achievement of LOs.*

C. Plan and execute an actionable evaluation of the curriculum and instruction.

Documenting and sharing in curriculum and instruction

The curriculum, whether or not it results from following the five phases discussed here, should be fully documented, describing how the program was conceptualized, and the assumptions and decisions made in the process (American Educational Research Association, 2014). This documentation should be shared with all stakeholders, including instructors and learners¹². Changes to the instruction (e.g., selection of new LEs or content) can be justified when the process is fully documented and shared/available. Impacts of such changes can then be studied to better understand what was intended, what was done, and why those might have diverged, if they do. Documentation about assumptions and decisions in the development (or revision) of curriculum and instruction can be particularly helpful in preparing and certifying new instructors for that curriculum; it also has ramifications for adult learners – transparency of the intended and actual curricula allows them to capitalize on their prior learning, participate in the LE as partners in their own education (Knowles et al., 2006), and make informed choices about their learning goals and how best to achieve them.

Documentation of a curriculum or instructional opportunity can also support decision-making by self-directed learners, particularly as they develop their metacognitive abilities to identify and evaluate strategies for learning (Ambrose et al., 2010, pp. 188-216). Individuals with low levels of knowledge/experience are demonstrably unable to accurately gauge how they perform, what they have learned, or what they need to learn in order to perform better (Kruger & Dunning, 1999). However, sharing the instructional decision-making, and making the criteria for assessment of learning explicit, may help to increase learners' abilities to self-diagnose.

Following the five phases makes documenting each step more straightforward. *Creating useable documentation, and sharing it with instructors (including those who teach only part of a curriculum) and learners, can support learning and the success of the curriculum or instruction.*

D. Document and share the features of the curriculum or instruction – including criteria for their success – with learners.

Discussion

Nicholls' five phases of curriculum design are relevant for formal curricula and short-form training experiences, but other models may also be useful (e.g., El Sawi, 1996; Diamond, 2008). Approaches like Nicholls', based on cognitive and psychological literature, feature formality and structure, because these specifically promote consistency across the curriculum and coherence between the learning that is intended and instruction that is delivered. The starting point, and essential reference for later phases, is the articulation of LOs. LOs drive every decision, as shown in Figures 2 and 3. Bloom's taxonomy can support the integration of a developmental trajectory through a curriculum in terms of the cognitive complexity of stated LOs. This is also true for sequences of shorter training courses; an explicit developmental sequence of LOs can help self-directed learners to identify gaps in their capabilities and seek instructional opportunities to close

¹² This documentation has been proscribed for the educational community for decades but is also in line with newer thinking, including FAIR (Findable, Accessible, Interoperable, and Re-usable) principles that have been developed to describe international resources, including data and workflows, used in biomedical research, bioinformatics, and data science. See, e.g., Garcia et al. (in review).

them. Bloom's is the most widely used taxonomy, but others exist (Moseley et al., 2005). Messick's questions (and variations thereon) facilitate alignment of instruction and assessment, and the alignment of teaching and curricular goals. Although general topic areas (e.g., physics, biology) provide the necessary framework, the specific content is not the starting point for curriculum or instructional design. Instead, the goals for learners with respect to *any* particular content should drive how that content is taught and assessed.

Figure 3. Challenges and options in implementing Nicholls' curriculum-development model. Each phase informs the next (horizontal arrows). Challenges may arise at any point; but options are available to help accomplish each phase, or to address these or other challenges that may arise along the way.

Most guidelines for curriculum and instructional development focus on following these phases, or some version of them. However, as Figure 3 shows, when trying to implement Nicholl's model, various challenges may be encountered along the way. For example, as already mentioned, some aspects of a curriculum or instruction may be fixed, which may lead to a gap between the intended and actual curricula if fixed elements are not aligned with, or supportive of, LOs. These guidelines offer options and can support the initiation of a conversation about the best strategies to identify, and possibly remediate, such misalignments.

Considerations for training and self-directed learning

Designing instruction is challenging, requiring thought, attention and time; this is just as true for short-form and self-instruction as it is for curricula and programs of study (Diamond, 2008). Self-directed learners need to make informed decisions about which training sessions will be most likely to help them achieve their own learning goals; they therefore need to develop a sense of whether

particular learning opportunities or LEs can actually support the stated LOs (e.g., in order to be able to choose between several different offerings of a 'data science' course that appear superficially similar). Similarly, trainers need to focus on, and make informed choices about, the LEs that best align with the objective of achieving specific LOs in the time available.

Assessment presents greater challenges for training and self-directed learning. Trainers can use short- and longer-term evaluations to determine, say, interest in, or consistency in implementing, the training material; but formative assessment is generally the most relevant assessment tool for this context. Self-directed learners may be unlikely to create formative assessments, but they may formulate LOs for themselves and then try to determine whether they have met them, or whether they need to augment their learning with supplemental reading or exercises/activities. Job descriptions and published descriptors (the European Qualifications Framework (European Communities, 2008), etc.) can be leveraged by self-directed learners and trainers; these concretely describe specific KSAs that can be used as *targets*, against which to compare the LOs or LEs they are considering.

Institutional context

When engaging in curriculum- or instructional-development efforts, it is important to ensure that your institution is supportive of the process (El Sawi, 1996; Diamond, 2008). Curriculum or instructional development will be impeded (or impossible) if your institution cannot support such efforts owing to LO, content, or accreditation requirements that cannot be modified; or limitations on time or class size, resourcing (e.g., availability of equipment, instructors, etc.), and other such factors. Figure 3 notes some of these potential challenges, and suggests various options that may be helpful in trying to address them.

Successful curricula and courses ensure that instruction supports learners as they develop from entry-level performance to the minimum qualification for completing the program or course, articulated in terms of specific LOs. With effective curriculum and instructional design, course completers will have accrued sufficient evidence for any observer to determine their qualification. A curriculum that is evaluated can document its potential to lead learners to achieving its learning goals (Banta & Palomba, 2015, Chapter 2); actionable evaluation will identify specific aspects of the curriculum or instruction that may benefit most from an intervention to correct any deficits in learning-goal achievement.

When curricula are designed specifically to support learners and LOs, and are evaluated against that objective, the actual and intended curricula are more likely to match. This cannot guarantee successful outcomes for every learner, but does create the optimal circumstances for success. Curriculum-development projects should consider these formal, structural supports. Ultimately, everything in the curriculum should lead to, and support development of, the LOs that students should possess and be able to demonstrate on completion of a LE or sequence of LEs. LEs, and the content they use/introduce, should thus be selected specifically for their contributions to the achievement of LOs.

Conclusion

When designing curricula or short-form training courses, it can be helpful to follow a formal structure, in order both to benefit from what's known about learning and to provide a framework for decision-making. This may prove challenging, but investment in the process is likely to pay dividends to instructors and learners alike. For ease of reference, we have distilled what may seem like a daunting process into a set of simple guidelines, which are summarized in Table 1. Following these, we hope, will support you in successful curriculum and instructional development in future.

Table 1. Summary of guidelines for curriculum and instructional development.

Guideline	Benefits	Further reading
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A. Identify and follow a formal paradigm for curriculum or instructional design.	Leverages what is known about education & learning. Provides structure & a framework for decision-making.	Nicholls G. (2002). <i>Developing teaching and learning in higher education</i> . London, UK: Routledge Falmer.
B. Focus on LOs first, to inform all other decisions about the curriculum and instruction.	LOs provide structure & context for decision-making by instructors & learners.	https://teaching.cornell.edu/teaching-resources/designing-course/setting-learning-outcomes https://teachingcommons.stanford.edu/resources/course-preparation/creating-syllabus/learning-goals
B1: Leverage LOs to explore and identify appropriate LEs.	LOs help instructors to choose LEs that support learners in achieving desired LOs.	O'Brien JG. (2008). <i>The Course Syllabus, 2E</i> . San Francisco, CA: Jossey Bass.
B2: Leverage LOs to select content that is appropriate for the LEs and promotes the LOs.	LOs help to focus on relevant content, & to avoid material that is non-essential &/or too narrow.	Nilson L. (2016). <i>Teaching at its best: A research-based resource for college instructors, 4E</i> . San Francisco, CA: Jossey Bass.
B3: Assess learning based on achievement of LOs using formative and summative assessment, as appropriate.	LOs clarify what specifically needs to be assessed & why.	Fink LD. (2013). <i>Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses, 2E</i> . San Francisco, CA: Jossey Bass.
C: Plan and execute an actionable evaluation of the curriculum and instruction.	Helps to identify what works & what needs remediation in the instruction or curriculum to better support the achievement of LOs.	Diamond RM. (2008). <i>Designing and Assessing Courses and Curricula, 3E</i> . San Francisco, CA: Jossey Bass.
D: Document and share the features of the curriculum or instruction – including criteria for their success – with learners.	Helps to support learning & promotes success of the curriculum or instruction.	Knowles et al. (2006). <i>The Adult Learner, 6E</i> . London UK: Elsevier.

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