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III. Teaching and Technology in Support of Personalized Learning

Personalizing Curriculum: Curation and Creation

Karen L. Mahon

A personalized curriculum is one that has been crafted to provide students with individualized learning opportunities. As the use of personalization strategies has become more popular, the challenges of curating (i.e., selecting) and creating personalized curriculum resources have come to the fore. In particular, there is no systematic method by which educators learn to select and create curriculum resources that support personalized instruction. This has led to widespread confusion about what personalized instruction is and is not and has produced wide variety in what educators are applying in the name of personalized curriculum.

This chapter endeavors to provide a roadmap for educators who are selecting and creating resources for personalizing curriculum. The chapter is presented in two parts: first, descriptions of the best practices and discouraged practices for personalization are presented; second, the research base that determines whether a practice is recommended or discouraged are discussed.

Best Practices in Proven Methods of Personalization

The first section of this chapter focuses on personalization methods that have demonstrated a positive impact on student learning outcomes in the educational research literature. These practices are recommended to be included in instruction and in the resources that are selected or created in order to personalize instruction. Recommended methods include goal setting, feedback, periodic formative assessment, deliberate practice, and peer tutoring.

Goal Setting

Goal setting entails describing and defining the learning outcomes that an individual student should achieve on completion of an activity, module, or other unit of curriculum. Goals typically include not only the level of achievement to be reached but also the amount of time in which the achievement should be accomplished. According to Locke and Latham (1990), goals inform individuals "as to what type or level of performance is

to be attained so that they can direct and evaluate their actions and efforts accordingly" (p. 23). Furthermore, Locke and Latham suggest that goals regulate action, explain the nature of the link between the past and the future, and assume that human goals are directed by intentions.

Performance goals should be specific, so that teacher and student have a shared understanding of the expectation, and they should be challenging relative to a student's current repertoire. Goals are likely to be very effective as a personalization strategy when cast in terms of "personal best" targets for individual learners. Personal best targets are especially positive because they give the learner the opportunity to compete only with herself, improving on her own previous performance, not with peers who may have higher skill levels. Goal setting need not be collaborative between teacher and student; effective teachers should set appropriately challenging goals that are personalized for individual learners and then arrange the learning environment to help learners achieve those goals.

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Some digital resources evaluate performance and set a goal automatically and is a feature to look for when selecting products. When using a resource—high tech or low tech—that does not provide a goal, administering a pretest and setting a performance goal for the learner to achieve is recommended. Evaluate a student's current performance relative to mastery, then set an appropriate and achievable, yet challenging, goal that is an appropriate "personal best," given the student's current level.

Feedback

Feedback is information that a learner receives about his performance. Locke and Latham (1990) state that feedback allows learners "to set reasonable goals and to track their performance in relation to their goals so that adjustments in effort, direction, and even strategy can be made as needed" (p. 23). The rule of thumb for feedback is that it should be specific, immediate, and frequent. When feedback is specific, it includes statements such as, "You did a great job adding numbers today" instead of the more general and vague, "Great job." In the former case, the learner gets information about what, precisely, he did well. In the latter case, the lack of specificity leaves the feedback open to interpretation, thereby leaving the learner unsure of what he should be doing more of (or less of, in the case of corrective feedback) going forward.

The more immediately feedback is given following a response, the more closely the learner will associate the feedback with the task and be able to recognize clearly what she did that earned that feedback. "The way you pronounced the word 'thorough' wasn't quite right. Let's try again" immediately following the learner's speaking the word aloud is more informative than the same statement three hours after the reading aloud took place. The feedback is more easily assimilated if the recipient does not have to struggle to remember the performance that is named, particularly if the learner made a mistake. Giving immediate feedback does not mean that *every response* must be followed by immediate feedback. It just means that when feedback is given, it should follow the target response as closely in time as possible.

Finally, feedback should be delivered frequently. Frequent feedback lets learners know how successfully they are moving toward their goals as they progress. This is especially

critical for learners who make errors; as they work to correct their errors, frequent feedback to shape their performance in the direction of mastery not only helps with accuracy, but it also helps keep them motivated.

When selecting digital products, test drive them to make sure that feedback for correct answers and errors is included. The higher quality instructional products will have feedback. If a digital product does not have embedded feedback or if a low-tech product has been utilized, the feedback will need to come from the teacher. Using feedback to personalize instruction for individual learners comes naturally to most teachers, without any special effort, but teachers may also build in places in the curriculum materials where students are prompted to ask for feedback. As long as the feedback is specific, it is automatically personalized for the learner because individual learners, compared with one another, do different things well and make different mistakes. As the teacher observes her students, she will likely see that the struggling learners need more frequent feedback, both to correct their errors and to help keep them motivated by pointing out what they are doing correctly. One of the keys in personalizing instruction with feedback is to be careful not to forget to give feedback to the more successful learners as well because often they are overlooked in favor of the students who require more support. In general, the goals are to keep feedback specific and immediate for all learners and to vary the frequency of the feedback depending on individual learner needs.

Periodic Formative Assessment

Periodic formative assessment includes regular and planned checks of progress toward the student performance goals set out for the curriculum. Formative assessment does not change student grades; it is not "testing." Conversely, it is intended to provide feedback to the teacher about which content the student is mastering and which content the student may be misunderstanding so that corrections can be made quickly. With formative assessment data, the teacher (or digital program) is able to make adjustments to the curriculum path, introducing remediation to clear up any difficulties the individual student may have with the content, speeding up the pace of the content or slowing it down. Thus, the student experiences personalized interventions as the curriculum path changes to meet his individual needs, whether designed by a teacher or a software algorithm.

One important benefit of ongoing formative assessment that is included in digital instruction is that it automatically adapts difficulty levels, depending on the learner's performance. This happens on the fly, without the learner or an adult needing to change settings in the program. The key to this is the automatic piece, regardless of whether it is used in online curriculum, computer-based software, or mobile apps running on a device. On a response-by-response basis, the curriculum adjusts its level of difficulty to what is most appropriate for the individual learner based on the pattern of responses produced by that learner. The algorithms that the curriculum uses to make branching and looping decisions can vary. Some curricula adjust based on a single user response. Others adjust the curriculum path based on a moving window of responses: an example is a program that is always looking at the five most recent responses and adjusting on that basis. The best algorithms look not only at correct responses (i.e., "hits") and errors (i.e., "misses") but also at "correct rejects" (i.e., what answer options a learner rejects when she makes a correct response) and "false alarms" (i.e., the answer option that a learner chooses, erroneously, when she makes a mistake). The more sophisticated the performance tracking in a

program, the more sensitive that program can be in adjusting to particular student learning needs.

These adjusting levels of difficulty are, effectively, ongoing formative assessment. Adapting levels of difficulty in digital instruction provides the same tailoring opportunity that a teacher has when using feedback from formative assessment. Just as a teacher makes adjustments to a curriculum based on formative assessment data, so too does a digital program make adjustments to its curriculum based on the student performance data that it collects. The difference is that a digital program, when being used *simultaneously* by multiple students, can make different personalized adjustments for each student *simultaneously*. The decision-making algorithms allow the program to take some of the load off of teachers in personalizing instruction, and because digital programs track the history of response patterns (thus giving it a long memory), it can adjust more effectively on the fly than a person can. One can think of this process as the student and program "co-creating" a personalized curriculum path.

Formative assessment and adapting levels of difficulty allow teachers to avoid what is known to be least effective for students—a "one size fits all" approach. In the case of digital resources, every interaction the student has with the curriculum is recorded, typically, and some programs have the capability to adapt levels of difficulty automatically, as described earlier. It is recommended that instructional digital resources are selected that do have that capability. Be mindful that programs that have adapting levels of difficulty are more expensive to make; developers have to put more time and effort into designing different curriculum paths and decision-making algorithms that allow the adapting to occur. A program that can automatically personalize to an individual students' needs is more complex than a program that has a linear path through the same set of 50 questions, for example.

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In the case of using low-tech approaches, teachers should consider embedding formative assessment opportunities into their lesson plans. This can be done in numerous ways, from technology-enhanced formative assessment, such as using a student response app that runs on mobile devices (e.g., Socrative, Inc., 2015), to something as low tech as giving students pieces of colored construction paper and asking them to raise the piece of paper that corresponds to the correct answer to a question presented by the teacher. Regardless of the method of data collection, the main point is for teachers to create assessment items that focus on the most critical target performances and to plan when these checks will occur during a learning session or lesson. The goal is to get insight into student progress and for the insight to occur regularly enough to make modifications to instruction and address misunderstandings and errors before they become habits. The formative assessment itself is not what is personalized; rather, the clarification and modification of the curriculum, on a student-by-student basis and in response to the formative assessment, are personalized.

Finally, graphing formative assessment data is recommended. The effectiveness of formative assessment is even greater when both the teacher and learner can see the progress displayed visually. In the case of digital solutions, look for products that include graphing and visual display. When creating curricula, teachers can include this opportunity to graph progress at regular intervals.

Deliberate Practice

Deliberate practice is the arrangement of many opportunities for active responding in a period of instruction. Unlike "time on task," which comprises all time—both active and passive—spent in the presence of a task, deliberate practice focuses intentionally on the active responding and the opportunities created to encourage active responding. Examples of active responding include "behaviors such as writing, oral reading, academic talk, asking questions, answering questions, and motor behaviors involved in participating in academic games or tasks" (Greenwood, Delquadri, & Hall, 1984, p. 65). Increasing active responding through deliberate practice also increases the likelihood that students will pay attention and stay on task.

Deliberate practice is not simply "drill and practice" but rather relies on the inclusion of feedback and established performance criteria. A student responds actively, and immediate feedback is given about the correctness of the response, which allows the student to modify her next response, if necessary. The greater the number of opportunities to respond actively in a period of academic instruction, get feedback, and respond again incorporating that feedback, the faster an individual student will achieve mastery performance.

Think of the example of a student learning to play the piano. Imagine that the student engages in deliberate practice for an hour a day, making, perhaps, hundreds of keystrokes and getting feedback from a teacher. A student in that scenario will make much more progress, much more quickly, toward playing the piano with competency than a student who may spend an hour a day *listening* to piano music but only performing a handful of active keystrokes.

Whether choosing a high- or low-tech resource, the key is to select materials that provide numerous opportunities for learners to respond actively to the materials within a fixed period of time. Many digital programs include a timed component wherein learners must not only respond actively but must also do it quickly (i.e., building fluency) but other digital programs and all low-tech activities do not. The most critical aspect in choosing resources is to select those that have many response opportunities; a teacher can easily add her own timing component to any activity with a simple stopwatch. If the teacher is adding a timing component while working with a group of learners, it is important to remember that each learner can work on a different skill simultaneously; only the timing need be shared. Do not underestimate the utility of even a simple printed worksheet that has many problems on it, each requiring an active student response. Something simple and low tech like this can be more effective than the slickest digital tool that has limited active response opportunities and consists primarily of passive presentation of material.

When you are encouraging students to make many active responses quickly and start to see mistakes in accuracy, have them slow down. This is part of the personalization piece. When students have opportunities for active responding, focus on building accuracy first and then on getting faster. Different students will progress at different rates, but a focus on deliberate practice will facilitate progress toward mastery.

Peer Tutoring

Peer tutoring is the pairing of students to work together during the course of study. Peer tutoring is often implemented with more skilled learners tutoring less skilled and

struggling learners, but it is thought that one of the main reasons that peer tutoring works so well is that "it is an excellent method to teach students to become their own teachers" (Hattie, 2009, p. 186).

One type of peer tutoring implementation is classwide peer tutoring (CWPT), in which all students in a classroom are organized into tutor–learner pairs. Used to ensure that all students are actively engaged during academic instruction, CWPT increases students' opportunities for deliberate practice. Peer tutoring can be used for personalizing the experience of both students who have been paired; the challenges for and responsibilities of each student in the dyad will be different, depending on the skills and abilities of each learner. For example, if Katie is paired with a more skilled learner, the level of challenge for her will be raised, but she will have a student mentor to help her achieve progress. Conversely, if Katie is paired with a less skilled learner, then she will be the mentor; her challenge, then, is to teach skills to another student clearly and effectively. Depending on Katie's own level of skill in different topics, her teacher can personalize Katie's experience through these pairings.

Some digital products are built to allow more than one student at a time to use them. When selecting among these products for use in peer tutoring, be careful to select the collaborative products that allow individual users to *work together* to achieve a desired outcome, not products that allow users to *compete* with one another in real-time play. If you are pairing a more skilled student with a less skilled student using a collaborative digital product, make sure that the more skilled student understands how to use the product, what the learning goal of the product is, and how to monitor progress toward that goal before a session with the less skilled learner begins.

If the teacher is creating materials to be used in peer tutoring sessions, a job aid to be used by the more skilled student of the pair is recommended. This aid might entail a script to be followed, a flow chart for the desired sequence of activities, or a list of objectives that the less skilled learner must attain. In short, providing a road map for the tutor is useful in keeping the session on track, particularly when conducting a low-tech activity that is not being directed by an automated computer program.

Discouraged Methods of Personalizing Curriculum

The next section of this chapter focuses on personalization methods that have produced a neutral or negative impact on student learning outcomes in the educational research literature. These practices are not recommended to be included in instruction or in the resources selected or created in order to personalize instruction. They include self-directed learning and matching student learning styles.

Student-Directed Learning

Student-directed learning is the practice of giving students choice in or control over their learning activities or learning materials. Student-directed learning is often touted as allowing students to take responsibility for their learning (Checkley, 1995). Proponents of student-directed learning believe that this practice increases student motivation and engagement. Student-directed learning is perhaps one of the best known, most popular methods of personalizing instruction.

If teachers opt to implement student-directed learning practices in their classrooms, they should consider combining them with one or more of the proven methods of

personalization described earlier. The best practices of personalizing instruction can be implemented in a student-directed learning environment because they can be applied to any subject or topic that a student may select; they are subject agnostic.

Matching Student Learning Styles

Matching learning styles is a controversial method of personalizing instruction. The philosophy behind learning styles is that different students have preferences for different ways of learning (including auditory, visual, tactile, and kinesthetic styles) and that academic achievement is improved when teaching takes these style preferences into account by matching resources to the preferred learning style. It is recommended that teachers DO NOT use products or create curricula that rely on a learning styles approach.

The Research Base of Proven Best Practices of Personalization

Some methods of personalizing curriculum have been demonstrated to be far more effective than others in the empirical educational research. The following overview discusses the research undergirding the recommended best practices discussed earlier.

Goal Setting

In goal setting, achievement is enhanced to the degree that students have challenging rather than "do your best" goals relative to their present competencies (Locke & Latham, 1990). Difficult goals are thought to be more effective because they direct students' attention to the most relevant behaviors to achieve the goals (see Chidester & Grigsby, 1984; Mento, Stell, & Karren, 1987; Tubbs, 1986; Wofford, Goodwin, & Premack, 1992; Wood, Mento, & Locke, 1987). Student commitment to the goals does not appear to be necessary for goal attainment except in the case of special education students; with these students, explicit commitment to the goals makes a large difference (see Donovan & Radosevich, 1998; Klein, Wesson, Hollenbeck, & Ange, 1999).

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Martin (2006) found that one effective method in achieving goals was to set "personal best" targets. Personal bests "primarily reflect a mastery orientation because it is self-referenced and self-improvement based and yet holds a slice of performance orientation because the student competes with his or her own previous performance" (p. 816).

Feedback

Feedback has consistently been shown to be "among the most powerful influences on achievement" (Hattie, 2009, p. 173). The most effective feedback is immediate, providing information about the response that the learner has just made, thus allowing that student to act on the feedback (see Malott & Trojan-Suarez, 2004; Miltenberger, 2008). Feedback for correct answers is known to be even more important than feedback for mistakes (see Kluger & DeNisi, 1996).

The effectiveness of feedback has been so compelling for such a long time that its use is now part of common practice in education. The research basis for using feedback goes back more than 45 years and has been demonstrated across a wide variety of settings and performances, from student academic achievement (e.g., Fink & Carnine, 1975; Martin, Pear, & Martin, 2002; Reichow & Wolery, 2011; Trap, Milner-Davis, Joseph, & Cooper,

1978; Van Houten, Morrison, Jarvis, & McDonald, 1974) and teacher behavior (e.g., Cossairt, Hall, & Hopkins, 1973; Harris, Bushell, Sherman, & Kane, 1975) to sports skills (e.g., Boyer, Miltenberger, Batsche, & Fogel, 2009; Brobst & Ward, 2002; Smith & Ward, 2006), flight training (e.g., Rantz, Dickinson, Sinclair, & Van Houten, 2009; Rantz & Van Houten, 2011), and more.

Periodic Formative Assessment

In formative assessment, the feedback to the teacher accounts for its larger effect sizes than other typical teacher effects (Hattie, 2009). According to Beatty and Gerace (2008), the efficacy of formative assessment is strongly supported by empirical results (for which they cite Bell & Cowie, 2001; Black & Wiliam, 1998b, 2005; Sadler, 1989). Black and Wiliam (1998a), in particular, point out that "innovations which include strengthening the practice of formative assessment produce significant, and often substantial, learning gains" (p. 155) across ages, school subjects, and countries—gains "among the largest ever reported for educational interventions" (p. 155). Black (1998) and Stiggins (2002) suggest that formative assessment may help narrow the achievement gap between those learners who are low achieving from low-income areas and their counterparts in more affluent socioeconomic groups.

Mazur (1997) implemented technology-enhanced formative assessment with periodic questioning during his university lectures. Multiple-choice items were presented, the students selected the correct answers via student response devices, and Mazur conducted follow-up discussions to clarify misunderstandings. The proportion of students answering questions correctly always increased after the follow-up discussion. Furthermore, Mazur (2009) elaborated: "Data obtained in my class and in classes of colleagues worldwide, in a wide range of academic settings and a wide range of disciplines, show that learning gains nearly triple with an approach that focuses on the student and on interactive learning" (p. 51) through these formative assessment practices. Beatty and Gerace (2008) point out that Mazur's assertion is supported by quantitative evidence from use in undergraduate science courses across multiple topics (e.g., Hestenes, Wells, & Swackhamer, 1992; Smith et al., 2009).

When formative assessment data are evaluated according to evidence-based models, effect sizes are higher than when the data are evaluated just by teacher judgment. Furthermore, when these data are graphed so that patterns of progress can be observed visually, the effectiveness of formative assessment is even greater (see Fuchs & Fuchs, 1986).

Deliberate Practice

Walker, Greenwood, Hart, and Carta (1994) point out that increasing the rate of correct academic responses until a mastery-based success criterion is met is critical for teachers to implement. The increasing of rates of deliberate practice is what Hattie (2009) refers to as the "common denominator" to many effective instructional methods, such as direct instruction, peer tutoring, mastery learning, and even feedback. High rates of deliberate practice provide the opportunity to improve accuracy in responding to mastery levels, but they also improve fluency, or accuracy plus speed, as in the case of precision teaching (e.g., see Lindsley, 1992). In addition, deliberate practice is likely to lead to long-term retention of learning (see Peladeau, Forget, & Gagne, 2003).

Deliberate practice requires active responding. Classrooms that emphasize active responding during more than 50% of the allocated instruction time will produce higher academic gains (Greenwood et al., 1984). A number of strategies that increase the frequency of active student responding have demonstrated improvement in academic achievement (Narayan, Heward, Gardner, Courson, & Omness, 1990). These include CWPT (Cooke, Heron, & Heward, 1983; Delquadri, Greenwood, Whorton, Carta, & Hall, 1986), computer-assisted instruction (Balajthy, 1984; Stallard, 1982; Tudor & Bostow, 1991), self-directed learning (Kosiewicz, Hallahan, Lloyd, & Graves, 1982), use of response cards (Cooke et al., 1983; Heward et al., 1996; Munro & Stephenson, 2009), choral responding (Heward, Courson, & Narayan, 1989; Sindelar, Bursuck, & Halle, 1986), timed trials (Van Houten et al., 1974; Van Houten & Thompson, 1976), and guided lecture notes (Lovitt, Rudsit, Jenkins, Pious, & Benedetti, 1985). In all cases, the strategy is the same: increase active student responding. It is only the tactic used to increase the responding that varies.

Peer Tutoring

The use of peers as co-teachers has been found to be quite powerful. The data supporting the effectiveness of peer tutoring are strong, dating back nearly 40 years. Hartley's (1977) meta-analysis of the effect of instructional method on mathematics achievement found that peer tutoring was the most effective method of those compared. Peer tutoring was most effective when used as a supplement to teacher instruction, and cross-age tutors were more effective than same-age or adult tutors. Phillips (1983) found that peer tutoring was more effective for students in the acquisition phase, rather than the maintenance phase, of learning and with clear success criteria as targets. Rohrbeck, Ginsburg-Block, Fantuzzo, and Miller (2003) found that peer tutoring that was more "student controlled," including student involvement in goal setting and monitoring performance, was more effective than when those aspects were controlled only by the teacher.

The effectiveness of CWPT has been demonstrated in studies of individual classrooms (e.g., Delquadri, Greenwood, Stretton, & Hall, 1983) and in longitudinal studies with as many as nine schools participating (e.g., Greenwood & Delquadri, 1995; Greenwood, Delquadri, & Hall, 1989). It has been shown to establish skills at a faster rate, provide better retention of what students learn, and make greater advances in student social competence "when using CWPT compared to such standard instructional methods as teacher–student discussion, lectures, seat work" and others (Greenwood, 1997, p. 55).

Discouraged Methods of Personalization

Just as some methods of personalizing curriculum have been demonstrated effective in the empirical educational research, others have been shown to be less so. The following overview discusses the research undergirding the personalization strategies discussed earlier that are not recommended.

Student Choice or Control Over Learning

Available data do not support an effect on increased student learning outcomes of student-directed learning. In a meta-analysis from Niemiec, Sikorski, and Walberg (1996), a review of 24 studies examining learner control yielded an average effect size that was small and negative, suggesting that the average student is not helped academically by student choice and might even be better off without it. A second

meta-analysis of 41 studies, conducted by Patall, Cooper, and Robinson in 2008, showed that instructionally relevant student choice had no meaningful impact on task performance, intrinsic motivation, effort, or perceived self-competence.

Matching Student Learning Styles

Pashler, McDaniel, Rohrer, and Bjork (2008) report that, when asked, people will report preferences for how information is presented to them but that there is "virtually no evidence" supporting the notion that teaching according to those preferences impacts achievement. Similarly, in an extensive literature review, Coffield, Moseley, Hall, and Ecclestone (2004) point out that although learning styles has an intuitive appeal "in the idea that teachers and course designers should pay closer attention to students' learning styles," (p. 1) the available research does not support this approach in increasing achievement. In fact, Coffield et al. suggest that there is potential for the allocation of a learning style to turn into a "learning handicap" (p. 134) because learners fail to become competent with all styles of presentation. Some have proposed that matching learning styles may not help typically developing children but may be appropriate for children with learning disabilities, a hypothesis that was popular in the 1970s. Here too, however, the data do not support this notion (see Arter & Jenkins, 1979).

Action Principles for States, Districts, and Schools

The action items below recommend the building of a statewide, shared digital product repository and library and the creation of an online educator community.

Action Principles for States

a. Create an online repository in which statewide educators can list and link to the digital products they use. Resources should be tagged according to which personalization methods they include and can be categorized according to the methods used, subject, alignment to Common Core State Standards, and so on.
b. Create an online repository in which statewide educators can store and share their self-created content resources; resources should be tagged according to which personalization methods they include and can be categorized according to the methods they use; they can also be organized by district or school.
c. Create an online portal that allows teachers to communicate with each other and provide peer reviews of teacher-created content (Wiggins, 1996, 1997). Establishing this portal at the state level increases the probability of teachers finding peers who are tackling similar student personalization challenges, particularly in less commonly offered courses. This online portal should establish standardized criteria by which teachers can evaluate each other's content.

Action Principles for Districts

a. Provide training to member schools on how to evaluate digital products for personalization methods, and processes for tagging and categorizing those products according to the categories in the statewide digital repository.
b. Provide training to member schools on how to create curriculum resources that include effective personalization methods. Also train on processes for tagging and categorizing those products.

c. Train member schools in how to conduct consistent, criterion-based peer reviews, thus saving individual schools from having to reinvent the wheel by conducting these trainings themselves. Provide a floating expert to visit schools for ad hoc teacher training.

Action Principles for Schools

a. Create a folder in the statewide repository that includes a list of or links to the digital products that are owned or licensed by the individual school and available for immediate use by that school's teachers.
b. Add teachers' self-created resources to the school's folder in the statewide repository, tagging them appropriately.
c. Provide guidance for following a process to vet teacher-created resources.

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