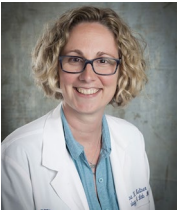


# BRIDGING THE GAP

## Training and Education in the Pathology and Cytopathology Sphere

Edited by Dr. Diane Davis Davey



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## Levering Adult Learning Principles Into a Residency Core Curriculum

Principles of adult learning have been well described for more than 50 years, with the basic tenets increasingly substantiated and refined through cognitive science research.<sup>1,2</sup> However, comparatively little has been published regarding integrating principles of adult learning into postgraduate medical training programs. At the University of Kentucky Department of Pathology and Laboratory Medicine, we explored and then implemented principles of adult learning and adult teaching, leveraging them into a novel 2-year curriculum, the Pathology Core Curriculum (PCC). In this brief review, we report the PCC structure, its reception by trainees and faculty, and its initial impact on Resident In-Service Examination (RISE) scores.

### **Baseline Curriculum and Performance/Competence of Our Residents**

#### *Prior curriculum*

Our preceding foundational curriculum extended over 2 years, so trainees experienced it twice during their residency. However, unlike the current PCC, the bulk of teaching occurred in a didactic (“sage on the stage”) manner. Initially, our chief residents were responsible for obtaining speakers; in other words, the curriculum was decentralized with limited deliberative oversight by residency program leaders. Quantitative assessment of knowledge retention was haphazard. Resident attendance at lectures was a nagging problem despite mandatory departmental attendance requirements. The attendance problem culminated in a program evaluation committee meeting in which we discussed the curriculum at length and reviewed our quantitative resident performance data to acquire baseline information about the state of resident learning.

#### *Boards and RISE scores*

Our department has always met the Accreditation Council for Graduate Medical Education requirement for an 80% minimum first-time American Board of Pathology certification examination (Boards) pass rate. However, we noted a downward trend in Boards scores among our residents over the past several years. This disquieting trend was also reflected in annual pathology RISE results. In agreement with the findings of Rinder et al.,<sup>3</sup> the few individuals with multiple repeated scores at or below the 25th percentile in subject areas of the RISE were the same individuals failing their first Boards attempt. Our data review, indicating a looming problem, spurred our education committee of 6 anatomic pathology (AP) and clinical pathology (CP) faculty members (EDUCORePS) to research adult learning principles as a potential means of reversing the downward trend.

#### *Initial Review of Adult Learning and Adult Teaching*

Our first step in revising our curriculum was thus preparatory and involved a review of adult learning and teaching principles. We focused on principles that were 1) proven effective for knowledge retention and retrieval and 2) feasible for incorporating into a residency training program. After our literature review, we selected 6 principles of adult teaching/learning we would mindfully lever into the PCC: 1) spacing, 2) concrete examples, 3) dual coding, 4) interleaving, 5) elaboration, and 6) retrieval practice (RP).<sup>2,4</sup> From the learner perspective, we chose metacognition and generation as strategies to supplement the 6 teaching/learning principles (Table 1).<sup>2,4</sup> Because RP offers multiple proven benefits, we prioritized RPs in the PCC.

**TABLE 1.** Principles of Adult Learning/Teaching

Teaching/Learning Principle	Definition	Example
Spacing	Spread teaching/learning over time.	<ul style="list-style-type: none"> <li>The 2-y curriculum is conducted twice (eg, spaced over 4 y).</li> <li>The same subjects are also covered in spaced clinical rotations.</li> </ul>
Concrete examples	Use specific examples to illustrate abstract concepts. Akin to storytelling.	<ul style="list-style-type: none"> <li>Review several in-house cases of pediatric round cell sarcoma to illustrate cytology and molecular genetic aspects.</li> <li>Residents experience actual patient cases during rotations that they can relate back to the PCC topic.</li> </ul>
Dual coding	Combine words with visuals.	<ul style="list-style-type: none"> <li>When presenting a case of papillary thyroid carcinoma, show the visual features and also verbalize them.</li> <li>When studying, describe the features verbally while reviewing the photomicrographs.</li> </ul>
Interleaving	Mix in related but distinct topics.	<ul style="list-style-type: none"> <li>Teach the microbiology diagnostics of head and neck infections while also teaching the histologic features.</li> <li>Do the same when studying.</li> </ul>
Elaboration	Dig deeper to ask why and how and make connections across subject areas.	<ul style="list-style-type: none"> <li>Teach common molecular genetic principles of adult versus pediatric sarcomas and ponder why and how there are major differences.</li> <li>Do the same when studying and cross-compare with other types of malignances in adults and children.</li> </ul>
Retrieval practice	Recall learned information from long-term memory for immediate use.	<ul style="list-style-type: none"> <li>Test the learner with relevant questions applicable to recent and more remote PCC teaching sessions.</li> <li>Do the same when studying</li> </ul>
Learning principle		
Metacognition	Self-reflect on one's learning.	<ul style="list-style-type: none"> <li>Use quantitative assessments such as retrieval practices and RISE examinations to monitor self-competency attainment.</li> <li>Make changes as needed or desired.</li> </ul>
Generation	Attempt to solve a problem before being taught the solution.	<ul style="list-style-type: none"> <li>Try to answer questions in a review book before the PCC teaching session.</li> <li>Review the correct answer to prepare for the teaching session</li> </ul>

Abbreviations: PCC, Pathology Core Curriculum; RISE, Resident In-Service Examination.

## Faculty and Resident Surveys

Although our education committee surmised that leveraging adult learning/teaching principles into our cyclical course should result in quantifiable improved learning, we recognized that needed changes would necessitate increased effort on the part of both the residents and the faculty. Consequently, the educational leadership enlisted the support of the faculty and the trainees. For the faculty, 3 members of the education committee individually met with key content experts and the chair to discuss the current educational state of the program, solicit suggestions for improvement, and request effortful participation in any changes. Unanimously, the interviewed faculty members concurred with the need for change, and they agreed to personally implement the changes, even should significant additional effort be required. Likewise, we discussed potential curriculum changes with an informal committee of the chief residents and other residents who had demonstrated an interest in education theory. Similarly, the residents unanimously concurred that educational program change was needed. Specifically, the residents enthusiastically endorsed our intention to emphasize RPs in the new PCC.

## Replacing bad study habits of rereading and massed practice

In the course of our interviews with residents, we were surprised to find that they favored rereading (with or without highlighting) and massed practice (cramming) over other study strategies. Rereading and massed practice are the least effective ways to learn and retain information over the long term.<sup>2,5</sup> Therefore, as one of our first actions in the new curriculum, we introduced the residents to a study technique proven to be effective: the study cycle.<sup>6</sup>

## Structure of the New PCC

### Schedule

The new 2-year PCC comprises formal learning interactions encompassing major topics in AP and CP organized by organ system. We purposely interleave CP and AP training, which is anchored by the specific organ system. For example, for the head and neck block, we intermix relevant microbiology and clinical chemistry sessions with head and neck surgical pathology and cytopathology sessions. Formal PCC teaching in June through August is replaced by introductory training sessions for new residents in which senior residents participate as assistant trainers (Table 2). In general, we engage in 5 to 7 formal teaching sessions per week.

### Teaching session formats

We convey content via multiple formats that repeat throughout the 2-year cycle to provide continuity. The formats comprise didactic sessions (favored by some content experts), team learning (Jeopardy style), rapid fire review of cases via short series of projected photomicrographs, surgical pathology and cytopathology unknown slide conferences, texted topical questions to the residents' smartphones, and, most importantly, RPs. Traditional didactic sessions have become consciously more interactive because learners previously exposed to the material can contribute their knowledge and experience for the benefit of their more junior peers: a 1-room schoolhouse model of teaching and learning. Residents new to the material, if adhering to the study cycle technique, can transform even the most traditional didactic sessions into active experiences by previewing the subject (specific reading is assigned beforehand and posted in an online calendar), taking hand-written notes (this requires thoughtful synopsis), and asking intrasession questions (this

**TABLE 2.** Pathology Core Curriculum Schedule (5-7 Formal Sessions per Week)

Year	Fall	Winter	Spring	Summer
Year 1	Gastrointestinal/liver/pancreas Central nervous system	Lung Cardiac	Endocrine Gynecologic	Introductory sessions for new residents and blood bank boot camp
Year 2	Head and neck Dermatopathology	Hematopathology Molecular genetics and pediatric	Genitourinary Breast Bone and soft tissue	

**Figure 1.** Daniel Griffin, MD, reviews one of his many self-created flash cards.

promotes elaboration). Teacher-led instruction designed to maximize active learner participation (its new iteration) extends far beyond a passive experience. The effectiveness of an invigorated didactic lecture can be high,<sup>7</sup> and it continues as a vital component of the PCC. Overall, didactic lectures now account for approximately 50% of the formal teaching sessions.

### *Periodic reaffirmation of the study cycle using concrete examples*

Throughout the PCC interactions, we continue to recommend optimal study habits. We have observed increased note-taking in formal teaching sessions, for example, and we verbally commend this habit as a key part of the study cycle. One of our senior residents (Daniel Griffin, MD) was inspired to create 6700 flash cards of AP and CP topics by using an online application (see Fig. 1). By creating the decks and regularly testing himself, he fluidly followed adult teaching/learning principles of spacing, interleaving, elaboration, RP, and metacognition. Thus, computerized or traditional flash cards (and, in our view,

**TABLE 3.** Retrieval Practice Question Annotation

Category	Example
Course title	Pathology Core Curriculum
Pathology specialty	Cytopathology
Domain	Preneoplastic
Body site	Uterine cervix
Image with the question	Yes (or no)
Question author	TJB (author initials)

particularly self-created ones) efficiently bundle key learning methods, as has been recently reported for medical students, for whom regular use of flash cards was the strongest predictor of passing the licensing examinations.<sup>8</sup> Laudably, Dr. Griffin has shared his flash cards with multiple other trainees, who are also adding their own novel flash cards to their personal decks. We are delighted to witness and support this spontaneous peer-to-peer teaching.

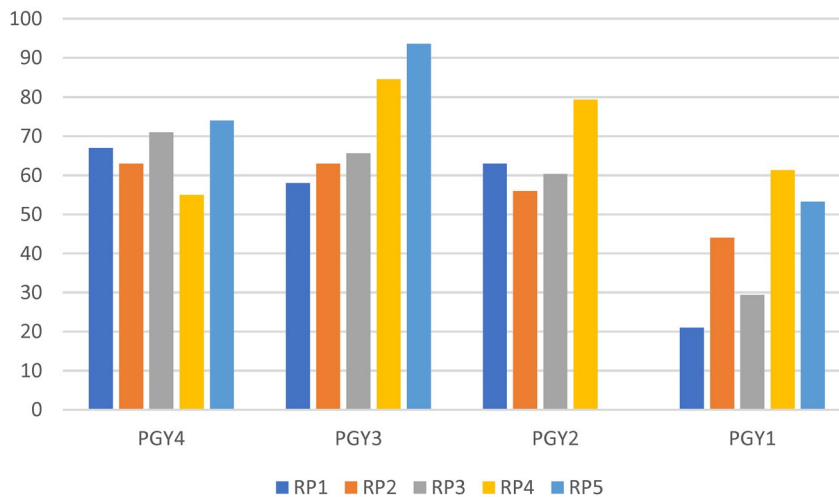
### *RP in more detail*

#### Rationale

RPs form the core of our new curriculum for 4 reasons: 1) well-written tests are innately highly effective for learning (“the direct testing effect”); 2) the results allow us to track comprehension and retention and make course corrections as needed more quickly and surgically, 3) the results provide the opportunity for metacognition by our residents; and 4) the results could serve as a safe and objective quantitative indicator that a resident is ready for increased responsibility in a corresponding clinical service role.<sup>9</sup> Using RPs as a low-risk meter of readiness to assume more responsibility aligns with the new “emphasis on providing an education program designed to promote a trajectory to independent practice” by the Accreditation Council for Graduate Medical Education.<sup>10</sup>

#### Mechanics

We use commercial software to create and house questions, administer the RPs online, and track answers. Tests are conducted in a defined time window to simulate the timing permitted in the Boards examinations. We schedule 1 to 3 RPs per organ system block. Each RP includes novel questions covering material from prior organ systems for spaced retrieval. Accordingly, we also administer semiannual cumulative RPs. We formally recognize high scorers (the highest overall scorer and the highest first-year resident score) every 6 months via an award certificate, a small gift card, and a public announcement. A critical component of each RP is the answer review session that occurs 2 to 4 days after the examination. Such deliberately spaced review sessions further enhance learning,<sup>2,9</sup> and residents usually ask elaborative questions in these reviews and are encouraged to do so. In toto, over the 2 years, we anticipate that our residents will undertake approximately 20 department RPs.



**Figure 2.** Representative resident RP scores for the first 5 RPs. They showed improvements over time. RP indicates retrieval practice. PGY, post graduate year of training.

**TABLE 4.** Resident and Faculty Survey Responses After Approximately 1 Year of the PCC

Resident Survey Responses Regarding PCC	Faculty Survey Responses Regarding PCC
<b>100%</b> answered that they felt that the new curriculum was improving their learning.	<b>100%</b> felt that they had adequate input in the new curriculum.
<b>93%</b> of residents felt that they had adequate input in the new curriculum.	<b>87%</b> believed that this system was improving resident learning.
<b>73%</b> changed the way that they studied, with comments revealing increased focus/organization and more regular and consistent reading.	<b>83%</b> preferred the new curriculum (the remaining 17% felt that the 2 curricula were comparable).
<b>71%</b> felt that the new curriculum helped them on their regular rotations.	<b>75%</b> believed that they would be more prepared for Boards in comparison with the old system.
<b>64%</b> feel more confident that they would pass Boards.	<b>62.5%</b> also believed that the new curriculum had led to better resident performance on rotations.

Abbreviations: PCC, Pathology Core Curriculum.

We annotate each question that we enter into the software by 6 categories (see Table 3). Annotation permits us to evaluate resident comprehension and retention in specific subject areas (such as the pancreas) and domains (such as cytopathology, molecular genetics, or flow cytometry) and by question author and question format. On a per-resident scale, we track performance through time (see Fig. 2). Interestingly and perhaps not unexpectedly, we found that nearly all residents showed improved performance over the course of the first 6 RPs (Fig. 2). We can correlate performance with external factors as well, such as rotation experiences, for example.

As with annotation flexibility, the RP software also enables multiple question formats. In addition to multiple-choice questions (MCQs), we also use free-text answers, short essays, matching, true-false questions, image identification, table completion, and other types, which in aggregate outnumber the MCQs. Using a wide range of question types rather than just MCQs complies with the data showing that open-ended questions further strengthen RP-related learning.<sup>11</sup> We now have a bank of approximately 750 questions midway through our first PCC cycle.

### Reviews by Trainees and Faculty

Although EDUCORePS and our chair were enthusiastic about the new curriculum and anecdotally we were receiving positive comments, after 8 months of the PCC, we conducted a formal anonymous survey of residents and faculty to obtain detailed feedback. Fifty percent of PCC-participating faculty and 100% of the residents completed the survey. A majority of faculty members and residents supported the PCC (see Table 4 for specific responses).

### Outcomes Measures of the PCC

Because the PCC is new and we are currently only midway through the first rollout, we have limited quantitative outcomes data. However, the data are promising. For the 2020 RISE, in subject areas that we covered in the PCC, our residents improved their RISE scores by twice the national average in comparison with 2019 scores for the same subjects (see Fig. 3 for the average overall pathology RISE examination performance over time). Resident attendance at teaching sessions (previously an issue) has uniformly improved, with all residents meeting the minimum attendance requirement. Additionally, by qualitative measures, the majority of our polled faculty members agreed that residents performed better on rotations as a result of the new PCC (see Table 4).

### PCC Course Corrections

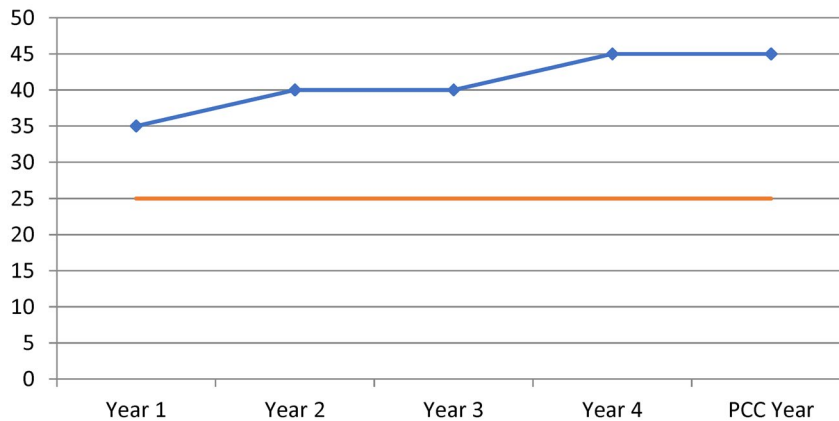
“Adult learning (andragogy) is not an ideology that must be applied totally and without modification. In fact, an essential feature of andragogy is flexibility.”<sup>1</sup>

### Recommendations by residents, EDUCORePS, and content experts

Anonymous recommendations by our residents included holding more interactive sessions, AP slide conferences, and CP sessions. Some residents found the volume of teaching sessions too high to balance with service obligations. Other residents requested more ancillary molecular testing information to be interleaved into AP sessions. Some residents requested only MCQ questions to better simulate the American Board of Pathology certification examinations (Boards).



## Overall Program Percentile



**Figure 3.** Overall Resident In-Service Examination scores stabilized after approximately 1 year of the core curriculum. PCC indicates Pathology Core Curriculum. Blue line represents our average program percentile; Orange line represents the threshold below which board failure becomes a significant risk.

Anonymous and nonanonymous recommendations by EDUCORePS and faculty members echoed some of the resident suggestions, including increasing CP and interactive sessions such as rapid case reviews and AP slide conferences.

### Changes implemented

As a result of these recommendations and further review by EDUCORePS, we have slightly increased the number of teaching sessions to accommodate more CP topics, and we have strongly encouraged content experts to present at least half of their material in an active learning format. We have continued to write predominantly non-MCQ-type questions because of their greater learning impact and subsequently have re-emphasized the high value of these question types with the residents. However, we changed our semiannual PCC RP to comprise MCQs exclusively (to model the Boards experience), as was requested by the majority of our trainees. As the PCC continues to grow and as we continue to assess effectiveness, we will modify it as needed. Thus far, only minimal changes have been deemed desirable and implemented.

### Coronavirus Disease 2019 Constraints

Fortunately, the PCC is resilient in the face of the coronavirus disease 2019 pandemic. We schedule active learning sessions in a large auditorium that enables social distancing. We administer RPs online in a timed fashion, and residents can take the examinations from home. More traditional lectures are delivered via Zoom.

### Conclusions

Early evidence suggests that our new PCC is remarkably effective. Increased comprehension and retention of pathology subject matter could be due to a combination of improved study habits, teaching formats predicated on adult learning principles, and multiple opportunities for residents to learn to dampen test anxiety. The new curriculum benefits greatly from commercial online examination software, and our chair has provided not only financial but also intellectual support for this major overhaul. For such an endeavor, senior leadership

buy-in is essential. Finally, without the trust and effort of our faculty and residents, the PCC implementation would have been a lackluster endeavor. Instead, we believe that our residency training program now has tangible, robust reasons to expand this novel, adult learning-focused curriculum. Certainly, an approach similar to ours is also applicable to cytopathology rotations, cytopathology and other fellowship programs, and cytotechnology training programs.

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## References

1. Knowles MS, Holton EF III, Swanson RA. *The Adult Learner*. 8th ed. Routledge Taylor and Francis Group; 2015.
2. Brown PC, Roediger HL III, McDaniel MA. *Make It Stick—The Science of Successful Learning*. Belknap Press of Harvard University Press; 2014.
3. Rinder HM, Grimes MM, Wagner J, Bennett BD. Senior pathology Resident In-Service Examination scores correlate with outcomes of the American Board of Pathology certifying exams. *Am J Clin Pathol*. 2011;136:499-506.
4. Weinstein Y, Sumeracki M, Caviglioli O. *Understanding How We Learn—A Visual Guide*. Routledge Taylor and Francis Group; 2019.
5. Karpicke JD, Blunt JR. Retrieval practice produces more learning than elaborative studying with concept mapping. *Science*. 2011;331:772-775.
6. McGuire SY, McGuire S. *Teach Students How to Learn*. Stylus; 2015.
7. Christodoulou D. *Seven Myths About Education*. Routledge Taylor and Francis Group; 2014.
8. Deng F, Gluckstein JA, Larsen DP. Student-directed retrieval practice is a better predictor of medical licensing examination performance. *Perspect Med Educ*. 2015;4:308-313.
9. Larsen DP. Planning education for long-term retention: the cognitive science and implantation of retrieval practice. *Semin Neurol*. 2018;38:449-456.
10. Davey DD. New ACGME common program requirements will affect pathology and cytopathology training. *Cancer Cytopathol*. 2019;127:489-490.
11. Zaromb FM, Roediger HL III. The testing effect in free recall is associated with enhanced organizational processes. *Mem Cognit*. 2010;38:995-1008.

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