



Effective multilevel teaching techniques on attending rounds: A pilot survey and systematic review of the literature

Laura K. Certain, A. J. Guarino & Jeffrey L. Greenwald

To cite this article: Laura K. Certain, A. J. Guarino & Jeffrey L. Greenwald (2011) Effective multilevel teaching techniques on attending rounds: A pilot survey and systematic review of the literature, *Medical Teacher*, 33:12, e644-e650, DOI: [10.3109/0142159X.2011.610844](https://doi.org/10.3109/0142159X.2011.610844)

To link to this article: <https://doi.org/10.3109/0142159X.2011.610844>



Published online: 06 Jan 2012.



Submit your article to this journal [↗](#)



Article views: 3602



View related articles [↗](#)



Citing articles: 3 View citing articles [↗](#)

WEB PAPER

Effective multilevel teaching techniques on attending rounds: A pilot survey and systematic review of the literature

LAURA K. CERTAIN, A. J. GUARINO & JEFFREY L. GREENWALD

Massachusetts General Hospital, USA

Abstract

Background: While numerous authors acknowledge the challenge of teaching simultaneously to medical students, interns, and residents, few offer specific advice on how to meet that challenge, and none have studied which techniques are most effective.

Aims: The purpose of this study was to determine whether multilevel teaching is challenging for attendings, whether trainees feel that teaching on rounds is appropriate to their level, and to define multilevel teaching techniques.

Methods: We surveyed attendings and trainees on the internal medicine services at two academic medical centers.

Results: Attendings were divided about whether teaching to multiple levels posed a challenge. Trainees reported that the teaching they received was usually appropriate to their level of training. The most effective techniques for multilevel teaching were Broadening (asking “what if” questions), Targeting (directing questions at specific team members), and Novelty (teaching newly published information), while the least effective were techniques that taught advanced material unfamiliar to most or all of the team. A systematic literature review yielded no studies that focused on multilevel teaching techniques.

Conclusions: This article is the first to define and evaluate specific techniques for multilevel instruction in a medical setting and identifies certain techniques as more effective at engaging multiple levels of learners simultaneously.

Introduction

A typical inpatient medicine team at a US teaching hospital consists of third- and fourth-year medical students, interns (doctors in their first year after medical school), residents (doctors in their second or higher year after medical school but not yet licensed to practice independently), and an attending physician (a doctor who has completed all formal training in a particular field). While the primary goal of the team is to provide patient care, another important goal is the education and training of the interns, residents, and medical students. One challenge to the attending, then, is to teach a group of trainees who come from varied backgrounds, have diverse interests, and are at different levels of training. For example, the attending must find a way to engage the third-year medical student, who is still learning how to characterize heart murmurs, while also engaging the senior resident who is about to enter a cardiology fellowship.

We searched the literature to identify techniques that had been studied and found to be effective methods for multilevel teaching on inpatient rounds. Several authors acknowledged this problem of teaching to multiple levels simultaneously (Maxwell et al. 1983; Weber 1983; Osborn & Whitman 1991; Irby 1992; Ende 1997; Ramani 2003; Castiglioni et al. 2008) and a few offered general advice on how to be an effective attending (Weber 1983; McLeod 1986; Kroenke 1992; Irby 1992 1994a, b; Schiffman 1996; Ende 1997; Ramani 2003), including advice on how to teach multiple levels of learners

Practice points

- Despite attendings' concerns about the challenge of teaching to multiple levels of learners on rounds, trainees at all levels found most teaching on attending rounds to be useful.
- Teaching techniques that helped facilitate learning among multiple levels of trainees included: Broadening, Targeting, Novelty, Up the Ladder, and Student as Teacher (see Table 1 for descriptions).
- If questions are constructed carefully, it is possible to challenge advanced trainees while also teaching junior trainees.

simultaneously (hereafter called “multilevel teaching”). Notably, however, none of these articles were actual research studies. We therefore planned a systematic review of the literature to attempt to identify any trials on the topic and commenced a new study of multilevel teaching techniques. For the study, we surveyed medical students, interns, residents, and attendings at two teaching hospitals to identify: (a) whether multilevel teaching is perceived as a problem or a challenge by attending physicians; (b) if trainees at various stages feel that the teaching they receive from attendings is appropriate to their level of training; (c) which multilevel teaching techniques are currently in use; and (d) if trainees perceive those techniques as effective.

Correspondence: L. K. Certain, Department of Medicine, Massachusetts General Hospital, Wang 615, 55 Fruit Street, Boston, MA 02143, USA. Tel: 617-724-6200; fax: 617-724-0393; email: lcertain@alumni.princeton.edu

Methods

Literature review

We searched PubMed (1960 to April 20, 2011) using the terms “teaching rounds” [MeSH Terms] OR (“teaching” [All Fields] AND “rounds” [All Fields]) OR “teaching rounds” [All Fields] OR (“attending” [All Fields] AND “rounds” [All Fields]) OR “attending rounds” [All Fields] and reviewed the titles of all results. We also searched the education research database ERIC with the assistance of a reference librarian from the Harvard Graduate School of Education (search: (SU (“individualized instruction” OR “curriculum differentiation”)) and (SU (adult* OR “higher education” OR “professional education” OR “medical students” OR “medical education”)) not (“special education” OR “teacher education”))). For all titles that related broadly to the topic of multilevel teaching (e.g., titles mentioning teaching on attending rounds), one author (Laura Certain) reviewed the abstracts and read the complete article of all relevant articles and those for which no abstract was available. We also reviewed reference lists from relevant articles and talked with local medical education experts to identify additional studies. Discussions with local medical education experts yielded no additional articles on the topic.

Survey

The study population for this article consisted of two groups: attendings and trainees. The attendings were internal medicine (IM) faculty who had served as teaching faculty within the past year on either the medical intensive care unit or general IM services at Massachusetts General Hospital (MGH), a 900-bed urban academic medical center and Newton-Wellesley Hospital, a 300-bed academic community hospital. The trainee group included all 2009–2010 IM house officers (“house officers” refers to interns and residents collectively; the same residency program serves both hospitals) and the third- and fourth-year medical students (all from Harvard Medical School) who had completed IM clerkships at MGH from September 2009 through February 2010. The house officers included both IM (a 3-year program) and combined medicine–pediatrics (MP, a 4-year program) trainees. We asked the trainees to identify themselves by their post-graduate year (PGY) as an intern (PGY1, IM/MP), a junior resident (PGY2 IM/MP, PGY3 MP), or a senior resident (PGY3 IM or PGY4 MP).

We created two different surveys, one for attendings and other for trainees; copies of the complete surveys are available from the authors upon request. Survey design was informed by discussion with an educational research specialist, a preliminary search of the literature, and a focus group of clinician educators. The attending survey consisted of nine items, four of which were demographic. The remaining five questions addressed whether the attendings felt multilevel teaching was a challenge (five-point Likert-type scale), which multilevel teaching techniques they used, and how often they used them. The survey asked attendings to describe their techniques in a free-response format first and then asked about their use of nine specific techniques (Table 1). We generated this list of techniques through observation of attending rounds and discussion with a

small group of expert clinician educators. The survey presented the techniques according to the descriptions in the second column of Table 1; it did not present the technique names.

The trainee survey had 14 items, three of which were demographic. The remaining questions asked respondents to consider their most recent 2 weeks on an inpatient medicine rotation. To assess “instruction appropriateness” the survey asked respondents to estimate what proportion of time teaching on attending rounds was: (a) below their level of training and boring/not useful; (b) below their level of training but a useful review; (c) appropriate to their level of training; (d) above their level of training but stimulated learning; and (e) above their level of training and not useful. The survey also asked which multilevel teaching techniques trainees had been used on their most recent inpatient medicine rotation and which of those techniques they found effective using the following scale: (a) no opinion, (b) not at all effective, (c) somewhat effective, and (d) very effective. As in the attending survey, the trainee survey first asked respondents to describe techniques they had seen (free-response question) and then asked about the nine specific techniques we defined.

In March 2010, the web-based surveys were distributed via email to 124 medicine attendings, 177 IM residents (71 interns, 59 junior residents, 47 senior residents), and 65 medical students (47 third-year, 18 fourth-year). We sent one reminder email to encourage completion but offered no incentives to complete the survey. The Institutional Review Boards of the MGH and Harvard Medical School determined this study protocol to be an exempt protocol.

Results were analyzed using R programming software (R version 2.4.0, R Foundation for Statistical Computing, Vienna, Austria, 2006) and IBM SPSS 19 (Chicago, IL). For all Likert-type scale questions in the attending survey, differences between groups were analyzed using the Pearson chi-squared test or Fisher’s exact test, depending on sample size, with the latter test used if the expected value for any cell was less than five. To assess the trainees’ perceptions of instruction appropriateness, 3×3 and 3×5 mixed analyses of variance (ANOVA) were conducted. The between-subject variable was trainee status (medical student, intern/PGY1, or resident/PGY2–4) while the within-subject variable was instruction appropriateness (divided into three or five levels). For the 3×3 ANOVA, the three “middle” levels of instruction appropriateness were grouped (below their level of training but a useful review; appropriate to their level of training; and above their level of training but stimulated learning) since all three could be considered useful teaching. For the 3×5 ANOVA, the five levels of instruction appropriateness were kept separate. We used the Bonferroni correction for multiple testing.

Results

Literature review

The initial PubMed search yielded 806 articles. Review of titles and available abstracts demonstrated that 94 of these articles seemed potentially relevant to multilevel teaching; after further detailed review, 17 articles demonstrated some relevance to the problem of multilevel teaching on attending rounds and

Table 1. Descriptions of multilevel teaching techniques.

Technique	Description	Example ^a
Broadening	Change the specifics of a given case to make it more challenging or interesting	"What if the patient were 45 instead of 75? How would that change management?"
Targeting	Target medical knowledge or management questions at specific team members based on the difficulty of the question	"Paolo, how do we decide if a patient with pneumonia needs to be admitted?... John, what are the most common bacteria that cause community acquired pneumonia?... Great. Susan, what are some of the possible complications of pneumonia that we should watch for in this patient?"
Novelty	Offer new data	Discuss a newly published article
Up the Ladder	Ask the same question to the medical student, then the intern, then the resident, etc.	"John, in this patient with a recent variceal bleed, what treatments should we consider?... Paolo, what do you think?... Susan, how do you think about it?"
Student as Teacher	Have a more senior learner train a more junior one	"Susan, can you show John how to evaluate for ascites?"
Multi-Answer	Seek many answers to the same question	"Here we have a patient with shortness of breath and a fever. What do you think is the most likely diagnosis and why?... OK, we've heard that Paolo thinks the patient has a PE because of a recent hospital stay. What do the rest of you think?"
No Right Answer	Ask questions with no single correct answer	"When and how should we tell the patient his diagnosis?"
Teaching to the Top	Teach to the most senior trainee on the team	"Susan, the next thing to try in a heart failure patient who is already on maximum doses of inotropic agents and cannot tolerate further afterload reduction is..."
Extreme Challenge	Teach at a level above everyone on the team	"One way to study the development of drug resistance is to do a haplotype analysis..."

Note: ^aThe characters in the examples are a third-year medical student named John, an intern named Paolo, and a senior resident named Susan. The "speaker" is the attending.

Table 2. Demographics of respondents.

<i>Attendings (N = 66)</i>	
Female (N, %)	20 (30)
Mean years of experience (mean, SD)	15 (12)
Self-identified title (N, %)	
Hospitalist	23 (35)
Specialist	17 (26)
Primary care physician	22 (33)
Physician-scientist	4 (6)
<i>Trainees (N = 89)</i>	
Female (N, %)	43 (48)
Median age (years)	28
Level of training (N, %)	
MS3	17 (19)
MS4	5 (6)
PGY1	31 (35)
PGY2/3	20 (23)
PGY3/4	16 (18)

are presented in the discussion below. However, for none of the articles was multilevel teaching the primary focus. The ERIC search yielded 92 articles, of which five were about individualized instruction and/or student-centered teaching; however, none was about applying those techniques to multiple learners at the same time or mentioned multilevel teaching as a challenge. Discussion with local content experts yielded no additional studies.

Survey

The attending survey response rate was 53% (66 of 124). The demographics of the respondents are presented in Table 2.

Of the attendings, 26% were less than 5 years out from completing residency/fellowship. The mean time since completing training was 15 ± 13 years; 30% of attendings were women.

Nearly 90% of attendings (59 of 66) agreed with the statement "While teaching, I try to teach to multiple levels of learners." When grouped by years since finishing residency or fellowship, there was no significant difference in the distribution of responses to this question (data not shown). Attendings were divided about whether or not they agreed with the statement "I find it difficult to engage multiple levels of learners at the same time on rounds." Overall, 32 agreed, 6 were neutral, and 27 disagreed with no significant difference by years since completing training (data not shown).

To identify novel techniques used by attendings to engage multiple levels of trainees in learning simultaneously, i.e., multilevel teaching techniques, we first asked attendings to describe techniques they used in a free-response format. We then asked them to identify whether they had used any of the techniques described in Table 1 during their most recent inpatient attending experience. All techniques spontaneously identified by the attendings surveyed represented only slight variations on those identified by our literature search and expert clinician educator focus group.

Of the 242 trainees surveyed, 89 (37%) responded to at least some of the survey questions. The median age was 28 and approximately half were women. To assess the trainees' perceptions of teaching on rounds, we asked them to estimate what proportion of teaching was at the appropriate level (for them) as opposed to above or below their level of training.

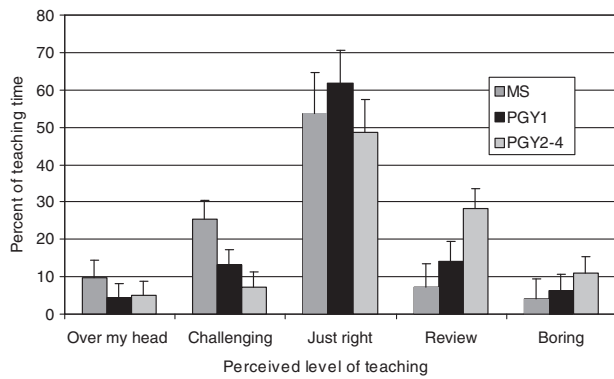


Figure 1. Perceived appropriateness of teaching. Mean estimated proportion of time that teaching on attending rounds was (a) above the trainee's level and not useful (Over My Head), (b) above the trainee's level but stimulated learning (Challenging), (c) appropriate to the trainee's level (Just Right), (d) below the trainee's level but a useful review (Review), or (e) below the trainee's level and boring/not useful (Boring). Error bars indicate 95% confidence intervals. Trainees are grouped by level into medical students (MS3/4), interns (PGY1), and residents (PGY2–4).

Results of the 3×3 mixed ANOVA showed that teaching was not evenly distributed across the various levels of appropriateness (a statistically significant within-subjects effect, $p < 0.001$). Trainees reported that $86.5 \pm 1.7\%$ (standard error) of teaching was useful (i.e., appropriate to their level, below their level of training but a useful review, or above their level of training but stimulated learning) while only $6.3 \pm 1.2\%$ of teaching was “above their level of training and not useful” and only $7.2 \pm 1.3\%$ “below their level of training and boring.” There was no statistically significant interaction effect by training year ($p = 0.12$); that is, trainees of all levels felt that over 85% of teaching was useful (neither too challenging nor boring).

In the 3×5 ANOVA, there was a statistically significant interaction effect ($p < 0.001$, Figure 1). Compared to higher level trainees, medical students estimated that a greater proportion of teaching was “above their level of training but stimulated learning” ($25 \pm 3\%$ of teaching time for medical students vs. $13 \pm 2\%$ for interns vs. $7 \pm 2\%$ for residents). Conversely, residents estimated a greater proportion of teaching was below their level of training (either review or boring). Compared to either medical students or residents, interns reported a greater percentage of time as appropriate to their level.

Trainees' recollections of teaching techniques used during their most recent inpatient rotation are shown in Figure 2, alongside attendings' reports of techniques they used. For every technique, it was more common for a trainee to report observing it than it was for an attending to report using it ($p < 0.05$ by chi-squared test for every technique; not corrected for multiple testing). However, the difference was most pronounced for Teaching to the Top and Extreme Challenge. In particular, while only 8% of (5/60) attendings reported teaching at a level above everyone on the team,

75% of (46/61) trainees observed attendings teaching at such a level. There was no correlation between level of training and the likelihood of observing Extreme Challenge or Teaching to the Top (data not shown).

To assess which techniques were the best at achieving multilevel learning, we asked trainees which techniques they found effective at engaging them in learning. Techniques that were ranked highly by all levels of learners were considered effective multilevel teaching techniques. Results are shown in Figure 3. For five of the techniques (Broadening, Targeting, Novelty, Up the Ladder, and Student as Teacher), more than 90% of trainees found the techniques either “somewhat effective” or “very effective” at engaging them in learning. For Broadening and Novelty, almost half of trainees perceived them as very effective (49% and 47%, respectively). Multi-Answer was also perceived by many trainees (86%) as effective at engaging them in learning. The remaining three techniques (No Right Answer, Teaching to the Top, and Extreme Challenge) were reported to be much less effective at engaging trainees in learning. There was no significant difference in responses by the different levels of trainees (i.e., medical student vs. intern vs. resident).

Discussion

Teaching on attending rounds poses the challenge of engaging a group of learners with diverse goals, interests, knowledge levels, and abilities. Our initial purpose in conducting this survey was to determine whether teaching to multiple levels on attending rounds is challenging for attendings and whether trainees feel that teaching on rounds is useful for their level of training. Overall, it appears that while many attendings remain concerned about how to engage learners of all levels on rounds, the vast majority of trainees feel that they are getting something out of the teaching provided. That is, trainees of all levels estimated that the bulk of teaching was either appropriate to their level, above their level but interesting, or below their level but a useful review.

Of note, the interns estimated that a greater percentage of time was spent teaching at their level than did either medical students or residents. This result likely reflects that attendings in US teaching hospitals often teach to the interns on the team. However, in the absence of effective multilevel teaching techniques, this focus on lower level trainees comes at the expense of boring the more senior residents (about 10% of the time by this survey). A goal of multilevel teaching on attending rounds is to reduce the amount of teaching that a trainee at *any* level judges to be over his/her head or boring. While a given teaching session or topic may be aimed primarily at one level of learner, with appropriate multilevel teaching techniques it should be possible to keep everyone engaged and learning.

Our second, larger purpose was to identify techniques in use and which of those were most effective at engaging trainees of all levels in learning. The techniques seen as most effective were Broadening, Targeting, Novelty, Up the Ladder, and Student as Teacher. These techniques are also perhaps the most familiar. All of them were volunteered by attendings when asked, in a free-response format, which techniques they

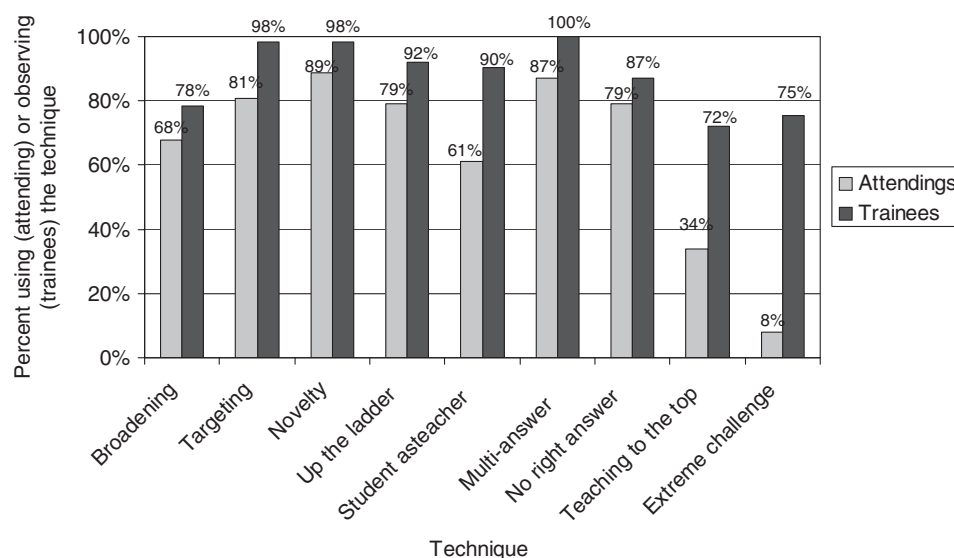


Figure 2. Estimated frequency of different techniques. Compares the percent of attendings who report having used a technique on their most recent teaching block to the percent of trainees who remember seeing the technique on their most recent rotation.

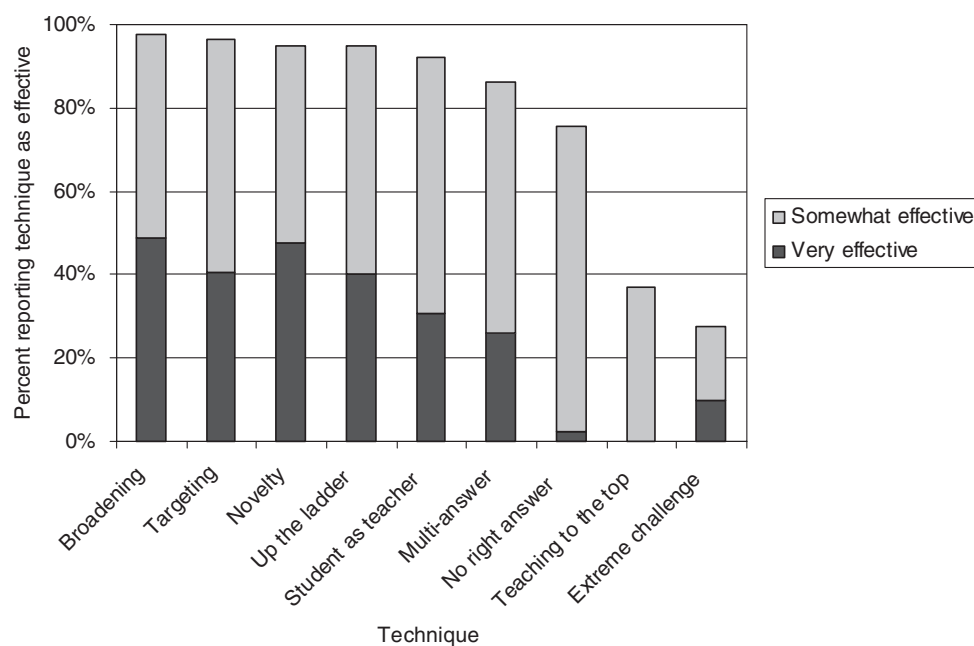


Figure 3. Trainees' perception of techniques. Of those who observed the technique, percent of trainees describing the technique as very or somewhat effective.

used to facilitate simultaneous learning for trainees at all levels (data not shown). This concordance between the techniques elicited by the free-response questions and the techniques identified *a priori* validates our list of multilevel teaching techniques. The least useful techniques were Teaching to the Top and Extreme Challenge. Of note, though very few of the attendings intentionally taught at a level above everyone on the team, many of the trainees perceived these techniques, reflecting a disconnect between teacher and student and a need for attendings to assess the stage of the learners more frequently.

Somewhat surprisingly, the literature review did not yield any data-driven articles on multilevel teaching. It did, however, yield articles offering expert input. First, there were articles that addressed the application of individualized instruction (also known as student-centered learning) to medical education (Newble & Gordon 1985; Newble & Entwistle 1986; McManus et al. 1998; Hassler 2005; Kinchin et al. 2008; Lacasse et al. 2009) and general adult education (Coffield et al. 2004; Cuthbert 2005; Lalley & Gentile 2009). In addition, several articles characterized the needs and actions of trainees at different levels on attending rounds (Foley et al. 1979;

Shulman et al. 1992; Elliot & Hickam 1993; Ways et al. 1996; Hoellein et al. 2007; Castiglioni et al. 2008; Tariq et al. 2010). Castiglioni et al. (2008) surveyed residents and interns about characteristics of successful attending rounds and found that the two groups differed in their responses. Residents most valued attendings who gave them autonomy, while interns valued those who taught throughout rounds (Castiglioni et al. 2008). These differences highlight the difficulties inherent in pleasing all members of the medical team, adding to the challenge of multilevel teaching. Other authors have likewise found differences in preferences between interns and residents (Shulman et al. 1992; Ways et al. 1996) and differences in engagement on rounds – medical students rarely speak and interns generally speak only when presenting a case (Foley et al. 1979; Elliot & Hickam 1993). Hoellein et al. (2007) analyzed residents' and students' perceptions of teaching on attending rounds and found that if students were more engaged and learning, then residents were less so (Hoellein et al. 2007).

Numerous articles offered general advice on how to be an effective attending (Weber 1983; McLeod 1986; Kroenke 1992; Irby 1992, 1994a, b; Schiffman 1996; Ende 1997; Ramani 2003) and some of these included advice on techniques that could reach multiple levels of learners. For example, an attending quoted in Irby (1994a, b) uses the technique of "hierarchizing knowledge – starting with the students at the basic science level, the clinical understanding level for the first-year residents, and then the more sophisticated understanding of the third-year resident." (Irby 1992) This description informs our understanding of the "Up The Ladder" technique noted in our study and explains how an attending can tailor questions and teaching to specific learners on the team. Kroenke (1992) offers other multilevel teaching techniques: asking the senior resident to teach more junior members of the team (akin to the technique we called "Student as Teacher"); asking questions with no right answer ("No Right Answer"); or teaching to the senior resident and letting the knowledge "trickle down" to the rest ("Teaching to the Top") (Kroenke 1992). Some authors have emphasized the importance of knowing your students and their needs (McLeod 1986; Irby 1994b; Ramani 2003), keeping everyone on the team engaged (Irby 1994a; Ende 1997), and staying case based and patient focused (Irby 1994a; Weber 1983). To our knowledge, however, no one has studied which techniques are most effective for multilevel teaching on attending rounds.

Because the medical literature was sparse on this topic, we examined the non-medical education literature for ideas on how to teach to multiple levels within one setting. If one considers the typical elementary school classroom, the teacher has to teach children at various levels of knowledge and ability, from diverse backgrounds, and with myriad interests.

One technique used in elementary education and adult basic education is *differentiated instruction*. The basic principle is to target the instruction, both content and style, to the individual learner (Corley 2005; Anderson & Algozzine 2007; Levy 2008; Rock et al. 2008). For example, a teacher could provide a variety of classroom projects on a given subject such that students of different ability levels could all participate. This technique could be used during attending rounds within

Targeting, such that medical students are asked to read the EKG for the attending while the intern discusses management of arrhythmias with the resident. A key feature of differentiated instruction is that teachers know the individual learners well and are therefore able to target teaching toward each one. While it is not reasonable to expect attendings to generate different lesson plans for each member of the team, more interaction and frequent feedback sessions between trainees and attendings would help the attendings learn the particular strengths, weaknesses, and interests of the team members and thus enable them to use techniques such as Targeting even more effectively. Another approach to a diverse school classroom is called *multilevel instruction* (Peterson et al. 2001). Proponents of this approach argue that differentiated instruction is really just parallel instruction of different ability levels and does not simultaneously teach everyone. By contrast, "authentic" multilevel instruction proposes that teachers teach to the highest level student in the classroom, but – by the questions they ask – provide "scaffolding" for the lower level students. An example for attending rounds might be to ask the senior resident, "What is the evidence for the use of ACE-inhibitors in diastolic versus systolic heart failure?" The question itself teaches medical students that we use ACE-inhibitors in heart failure, reminds interns to distinguish the different types of heart failure, and asks the senior resident to practice evidence-based medicine. Another basic tenet of multilevel instruction is aiming questions at higher order thinking, that is, ask questions that require evaluation and synthesis of data, not just knowledge or recall.

In light of the above description of multilevel instruction, one technique that deserves further discussion is Teaching to the Top or teaching to the most senior trainee on the team. Kroenke (1992) described this technique as "trickle down" teaching: "aim high, allowing more junior members to absorb what they can, filling out gaps in their knowledge through questions and further reading." (Kroenke 1992) Most medical students, interns, and junior residents did not find this technique particularly useful for learning. However, with modification to include scaffolding, this technique could become more effective at engaging the whole team in learning and higher order thinking.

There are several limitations to this study. First, our data only includes self-reported perceptual responses; we asked trainees which techniques they thought were most effective but did not test which techniques translated into the most effective increase in medical knowledge or skills. Second, responses were based on recollection and therefore may not accurately reflect the proportion of time attendings used the various techniques. Third, we did not link attending responses to trainee responses and therefore could not correlate responses from a given attending to responses from trainees on that attending's team. This lack of correlation may mean that the differences seen in Figure 2 are unrelated to each other. Fourth, we only surveyed trainees and attendings affiliated with a single residency training program. The results may not be applicable to other institutions. Finally, and most importantly, this study was a small, pilot study that only begins to answer the question of how best to teach multiple levels of learners on attending rounds. Despite the above limitations,

this study represents the first data-driven assessment of multilevel teaching on attending rounds. While further research is needed to elucidate other techniques and to clarify which are indeed the most effective at engaging all members of a medical team and promoting learning, the techniques described above provide a resource for attendings faced with teaching a diverse team.

Acknowledgments

The authors thank Dr Bayta Maring for assistance with survey design and Dr Deb Wexler for thoughtful critique of the manuscript.

Declaration of interest: The authors have no relevant conflicts of interest.

Notes on contributors

LAURA K. CERTAIN, MD, PhD, is an internal medicine resident at the Massachusetts General Hospital, Boston, MA, USA.

A.J. GUARINO, PhD, is a professor of Biostatistics at the Institute of Health Professionals, Massachusetts General Hospital, Boston, MA, USA.

JEFFREY L. GREENWALD, MD, is a faculty physician in the Inpatient Clinician Educator Service, Department of Medicine, Massachusetts General Hospital and an associate professor of Medicine at the Harvard Medical School, Boston, MA, USA.

References

- Anderson KM, Algozzine B. 2007. Tips for teaching: Differentiating instruction to include all students. *Prev School Fail* 51(3):49–54.
- Castiglioni A, Shewchuk RM, Willett LL, Heudebert GR, Centor RM. 2008. A pilot study using nominal group technique to assess residents' perceptions of successful attending rounds. *J Gen Intern Med* 23(7):1060–1065.
- Coffield F, Moseley D, Hall E, Ecclestone K. 2004. Learning styles and pedagogy in post-16 learning: A systematic and critical review. London: Learning and Skills Research Centre.
- Corley MA. 2005. Differentiated instruction. *Focus Basics: Connect Res Pract* 7(C):13–16.
- Cuthbert PF. 2005. The student learning process: Learning styles or learning approaches? *Teach High Educ* 10(2):235–249.
- Elliot DL, Hickam DH. 1993. Attending rounds on in-patient units: Differences between medical and non-medical services. *Med Educ* 27(6):503–508.
- Ende J. 1997. What if Osler were one of us? Inpatient teaching today. *J Gen Intern Med* 12(Suppl. 2):S41–S48.
- Foley R, Smilansky J, Yonke A. 1979. Teacher-student interaction in a medical clerkship. *J Med Educ* 54(8):622–626.
- Hassler A. 2005. Retaining students through individualized study skill training. *Inquiry* 10(1): 5–13.
- Hoellein AR, Feddock CA, Wilson JF, Griffith III CH, Rudy DW, Caudill TS. 2007. Student involvement on teaching rounds. *Acad Med* (RIME: Proceedings of the forty-sixth annual conference, 2007 November 4–7.) 82(10):S19–S21.
- Irby DM. 1992. How attending physicians make instructional decisions when conducting teaching rounds. *Acad Med* 67(10):630–638.
- Irby DM. 1994a. Three exemplary models of case-based teaching. *Acad Med* 69(12):947–953.
- Irby DM. 1994b. What clinical teachers in medicine need to know. *Acad Med* 69(5):333–342.
- Kinchin IM, Baysan A, Cabot LB. 2008. Towards a pedagogy for clinical education: Beyond individual learning differences. *J Further High Educ* 32(4):373–387.
- Kroenke K. 1992. Attending rounds: Guidelines for teaching on the wards. *J Gen Intern Med* 7(1):68–75.
- Lacasse M, Lee S, Ghavam-Rassoul A, Batty HP. 2009. Integrating teaching into the busy resident schedule: A learner-centered approach to raise efficiency (L-CARE) in clinical teaching. *Med Teach* 31(11):e507–e513.
- Lalley JP, Gentile JR. 2009. Adapting instruction to individuals: Based on the evidence, what should it mean? *Int J Teach Learn High Educ* 20(3):462–475.
- Levy HM. 2008. Meeting the needs of all students through differentiated instruction: Helping every child reach and exceed standards. *Clearing House: J Educ Strateg Issues Ideas* 81(4):161–164.
- Maxwell JA, Cohen RM, Reinhard JD. 1983. A qualitative study of teaching rounds in a Department of Medicine. *Proc Annu Conf Res Med Educ* 22:192–197.
- McLeod PJ. 1986. A successful formula for ward rounds. *CMAJ* 134(8):902–904.
- McManus IC, Richards P, Winder BC, Sproston KA. 1998. Clinical experience, performance in final examinations, and learning style in medical students: Prospective study. *BMJ* 316(7128):345–350.
- Newble DI, Entwistle NJ. 1986. Learning styles and approaches: Implications for medical education. *Med Educ* 20(3):162–175.
- Newble DI, Gordon MI. 1985. The learning style of medical students. *Med Educ* 19(1):3–8.
- Osborn LM, Whitman N. 1991. Ward attending: The forty-day month. Salt Lake City, UT: University of Utah Press.
- Peterson JM, Feen H, Tamor L, Silagy M, Gibson R, Beloin K, DeHart P. 2001. Whole schooling: A study of schools linking inclusive education & school reform in urban & rural communities research project. Final report. Learning well together: Lessons about connecting inclusive education to whole school improvement. Washington, DC: Educational Research Information Center.
- Ramani S. 2003. Twelve tips to improve bedside teaching. *Med Teach* 25(2):112–115.
- Rock ML, Gregg M, Ellis E, Gable RA. 2008. REACH: A framework for differentiating classroom instruction. *Prev School Fail* 52(2):31–47.
- Schiffman FJ. 1996. Morning report and work rounds: Opportunities for teaching and learning. *Trans Am Clin Climatol Assoc* 107:275–286.
- Shulman R, Wilkerson L, Goldman DA. 1992. Multiple realities. Teaching rounds in an inpatient pediatric service. *Am J Dis Child* 146(1):55–60.
- Tariq M, Motiwala A, Ali SU, Riaz M, Awan S, Akhter J. 2010. The learners' perspective on internal medicine ward rounds: A cross-sectional study. *BMC Med Educ* 10:53.
- Ways M, Kroenke K, Umali J, Buchwald D. 1996. Housestaff attitudes about work rounds. *Acad Med* 71(2):108–109.
- Weber ML. 1983. [Teaching rounds]. *Can Med Assoc J* 129(8):810–813.