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Evolving endoscopy teaching in the era of the millennial trainee

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Rapid popularization of interactive technology is a key determinant of the behavior and learning traits of the millennial birth cohort (see Fig. 1 for key dates in the technological life of a prototypical millennial).¹ These unique styles of thinking, acting, and learning are well-described.^{2–7} In fact, some procedure-based medical specialties have attempted to adapt their curricula to leverage these traits to enhance learning.^{8–13}

The literature on adapting endoscopy training to these distinct learning traits of millennials however is sparse. Engaging millennial trainees to learn more efficiently mandates applying non-traditional teaching tools in the cognitive aspects of endoscopy. In this perspective, we outlined millennial learning traits, reviewed approaches to active learning, and proposed discrete teaching interventions that may resonate with this group of trainees. Specifically, we examined experiential learning strategies and explored their application to the cognitive and technical aspects of endoscopy. It must be emphasized that improved learning by the new generation has a broad and important implication in the successful future of endoscopy.

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MILLENNIAL LEARNING TRAITS AND THEIR GENESIS

Gastroenterology trainees born between the early 1980s and the mid 1990s are the offspring of a generation that, by and large, experienced unprecedented prosperity and paid detailed attention to their children's development and education.^{14,15} School teachers nurtured them in small groups and used interactive learning techniques and technologies.⁴ A high degree of parental support and supervision encouraged participation in sports leagues and other extracurricular activities, thus inculcating multitasking from a young age.¹⁵ This type of upbringing is understood to have led to the common learning traits of millennials reviewed in Table 1.^{5,6,8,11,16,17}

NOVEL APPROACHES TO ACTIVE LEARNING IN THE CLASSROOM

Given these learning traits, it is not surprising that millennial trainees may favor active learning strategies such as self-directed learning, participation, group discussion, practice by experiential learning, peer-to-peer learning, and a strong influence of interactive technology.^{18,19} In fact, in medical schools, the learning strategies have changed toward self-study materials followed by flip-learning, small groups, learning using simulations, and early experiential learning with patients. We can expect that endoscopic training that leverages these preferences, as outlined in the following, may be more effective and efficient than traditional top-down, passive, or practice-based approaches that are the current norm.

Flipped learning

In flipped learning, trainees complete assigned readings, review multimedia, and learn basic concepts before attending lectures.^{12,20} This provides an opportunity for trainees to self-learn the background materials, whereas classroom time emphasizes mastering higher-level concepts. For instance, trainees talk through real-life scenarios while trainers moderate and ensure active participation from each trainee.

Peer instruction

Instruction by peers can enhance flipped learning and is more effective than conventional instruction by trainers.^{12,13} In peer instruction, trainees complete assigned readings with linked questions. Trainers engage trainees by posing additional questions and reviewing responses. Trainees discuss content among themselves and work collectively to provide explanations. Trainees are thereby compelled to better absorb and apply their readings. Table 2 summarizes a typical questioning procedure in peer instruction.^{12,13}

High-yield learning methods

Low retention rates are a hallmark of traditional passive didactic teaching.^{21,22,23} The following active learning techniques, commonly used in business and law schools, may enhance retention in medical training as well.

Jigsaw.—Trainees are tasked to become experts in one of many small parts of a topic, case, or paper assigned before a lecture. During the lecture period, individual trainees are

choreographed by the trainer such that the individual components of the topic fit together like a jigsaw puzzle to bring out a comprehensive picture for the trainees.

Role-play.—Trainees play a part to simulate real-life cases.

Think-pair-share.—When responding to a question, trainees pair with a peer, formulate a response, and share their consensus answer with the classroom.

Commitment activities.—When responding to a multiple choice question, each trainee commits to a response by using a polling device. Answering anonymously creates a sense of security and protection from being singled out for an incorrect response. Trainees then discuss the reasons for the incorrect responses as a group.

Problem-based cases

The key purpose of clinical scenario–based learning is to prompt trainees to become self-directed critical thinkers and problem solvers.²⁴

Case-based learning.—Trainees read and discuss complex, real-life scenarios. This develops their skills in analytical thinking and reflective judgement. After presenting a clinical scenario, trainers formulate questions and refer trainees to data sources (original literature, guidelines, accredited multimedia-based training, etc). Endoscopy clinical scenarios, ideally with video or photographs, can be used easily for case-based learning.

Problem-based learning.—Trainees are given freedom to study topics of individual interest and determine how they want to explore them, with trainers serving as facilitators (Fig. 2). An excellent resource for problem based learning can be found at www.maastrichtuniversity.nl/pbl.²⁵ In general, there are 3 key steps in problem-based learning. First, a preliminary discussion in which trainees, having read the prepared case, clarify the concepts, define the problems, brainstorm, analyze the problems, and formulate the learning objectives. Second, trainees collect information on their own and process this data to solve the problems. Third, they synthesize the solution together. The premise is that if the trainee can explain a problem, he or she should be able to use it in practice.

Learning management systems

Learning management systems²¹ are cloud-based platforms that can be used to frequently utilized to implement “flip” lectures and curriculum. They are cloud-based repositories containing relevant learning materials (literature, video, lectures, etc) in digital format at one location. Further, learning management systems can be used to measure trainee progress, such as completion rates of assigned materials and time commitment.

Incorporating simulation into flipped lectures, case-based learning, problem-based learning, or learning management systems

Incorporating endoscopy simulation games, a concept known as *gamification*, allows for a risk-free environment in which trainees can improve their endoscopic techniques, leveraging natural tendencies to compete and socialize.²⁶ Platforms may include computers, handheld

devices, or virtual reality. However, these technologies are still in their infancy and may be costly.¹²

APPROACHES TO ACTIVE LEARNING IN ENDOSCOPY ROOMS

Mastering the fundamentals of endoscopy is a formidable endeavor. The need to achieve deftness in both cognitive and technical aspects of endoscopy in a short period of time mandates revisiting existing teaching styles. At present, hands-on experience during patient encounters is considered the backbone of endoscopy learning, and many trainees believe they learn best by directly performing procedures.¹⁸ The knowledge gained is developed by rationalizing the experience. This model of training, however, is inefficient, incomplete, not standardized, and can lead to ingraining of suboptimal decision making and technical skill (bad habits). We therefore suggest an active learning approach to endoscopy.

Learning to recognize pathology

Endoscopic competency requires committing patterns of common pathology to memory. Trainees can learn pathology from select parts of endoscopy atlases and introductory videos. For example, before starting to perform colonoscopies, trainees should be familiar with the endoscopic appearances of the common findings and the must-not-miss findings. In addition, they should learn the classifications of findings. Reviewing endoscopic images or videos that show scale and detail of such diagnoses imprints pattern recognition.

Learning to arrive at a unifying diagnosis and treatment plan

Trainees must understand the accepted criteria for making diagnoses and learn to reconcile endoscopic findings with clinical, histologic, radiologic, surgical, and other data to arrive at a unifying diagnosis and treatment plan.

Using the flipped lecture strategy to prepare trainees before endoscopic cases

Prior to specific scheduled procedures, trainees, with the guidance of trainers, review literature, videos, and perhaps even simulate the situations. Trainees perform the procedure with trainers choreographing each intervention. Feedback given after a procedure offers trainees the opportunity to review their performances and refine techniques.²⁷ An example of an application of the flip lecture strategy in endoscopy is shown in Figure 3.

Using case-based learning and problem-based learning

These techniques can be expanded by applying case-based learning and problem-based learning in endoscopy training, including the technical aspects of endoscopy (Tables 3 and 4).

Using a structured learning environment

Trainers should establish clear objectives and expectations and give direct feedback.^{27,28} Using structured feedback to maximize learning during endoscopy should be based on a 4-phase cycle: (1) negotiate appropriate objectives for each endoscopy session; (2) observe the trainee during the session; (3) provide delayed feedback (debriefing after the procedure),

which might enhance performance of future procedures, and (4) help the trainee assimilate the feedback and set objectives for the next session.

Using models whenever possible in order to teach the mechanics of endoscopy

The Millennials learn best experientially. The use of models is aligned and most suitable to this learning trait.

Using standardized language and verbal cues

For example, *up* during colonoscopy means *look up*, *back* means *pull back the endoscope*, *stop* means *stop completely*. The command *stop* can be used to allow a trainee to receive feedback, especially when he or she has cognitive overload because of performing complex maneuvers or interpreting findings.

Using principles of game design

Endoscopy quality measures can be gamified to facilitate healthy competition for trainees to improve their endoscopy skills.²⁶ Gamified metrics could include correlation of optical diagnosis to histologic diagnosis, colonoscope insertion and withdrawal times, adenoma detection rate, and even patient satisfaction. Trainees are assigned anonymous identification codes and results are displayed to all trainees in leaderboard format.

LIMITATIONS AND CONCLUSIONS

Active learning strategies have been widely implemented in non-medical and some procedure-based medical specialties^{11,12,16,20,29,30} but not significantly in endoscopy training curricula.¹⁸

We believe that incorporating discrete participatory learning methods into endoscopy training may better suit the millennial learner. Indeed, digital technology is now part of daily life; the new approaches may therefore benefit endoscopists from all generations.

Abbreviations:

FIT	fecal immunochemical test
LST	laterally spreading tumor

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Figure 1.

Pivotal digital innovations rapidly shaped the millennial generation. To better understand, let us travel backward through time to catalog the exposure of a prototypical person of this generation to digital technology. We will call her Millennial Jane (MJ). AOL, America on Line (New York, NY, USA); YouTube (San Bruno, Calif, USA); iPhone (Cupertino, Calif, USA); Twitter (San Francisco, Calif, USA); iPad (Cupertino, Calif, USA); iMac (Cupertino, Calif, USA); Google (Mountain View, Calif, USA); Facebook (Menlo Park, CA, USA); RateMyProfessors.com (New York City, NY, USA).

Figure 2.

Problem-based learning involves a number of steps and is conducted over 2 or more sessions. Steps 1 to 5 are completed in 1 session. Step 6 may require multiple sessions.

Figure 3.

An example of an application of the flipped lecture strategy in learning an endoscopic banding technique we had used previously.

TABLE 1.

Learning traits of millennials

Learning characteristics	Explanation
Efficient thinking	The World Wide Web made it easier than ever before to instantly gather a plethora of information. Millennials are wired to find the easy, accessible, and efficient solution. Overall, millennials prefer audiovisual learning, and YouTube (San Bruno, Calif, USA) videos are essential in their education.
Active participation	Millennials are facile in gathering digital data and using it to solve problems. They prefer to be actively engaged without a hierarchical relationship. Learning has shifted from lecture-based training to a more interactive and collaborative model.
Experiential	Growing up with many technological advances, millennials learn through doing. They seek new approaches and are experimental.
Self-directed	Millennials prefer to be monitored, not led. They expect autonomy and trust and may challenge authority despite lacking professional knowledge and direction.
Regular feedback and recognition	Millennials feel most comfortable when receiving regular feedback. They keep an open line of communication and check in regularly with their educators. Mistakes are viewed as learning opportunities and a chance to improve. They do, however, expect recognition of their progress along the way.
Work/life balance	Millennials manage their time to ensure a balance between their work and personal lives. While previous generations tolerated or even embraced long and grueling work hours, millennials exert control over their schedules and choose their priorities.

TABLE 2.

Steps of questioning procedure in peer instruction/flipped learning

Trainer poses a question based on trainees' responses to pre-class readings.
Trainees reflect on the question.
Trainees commit to an individual answer.
Trainer reviews trainee responses.
Trainees discuss their thinking and answers with peers.
Trainees then commit again to an individual answer.
The trainer again reviews responses and decides whether more explanation is needed before moving on to the next concept.

Modified from Hopkins et al.¹²

TABLE 3.**An example of case-based learning**

A 70-year-old man without medical history undergoes colonoscopy as part of a colorectal cancer screening program. The colonoscopy showed a 5-cm LST in the rectosigmoid colon. There are no other polyps. Removal of the lesion is deferred, and the patient is scheduled for repeat colonoscopy with endoscopic resection of the LST.	
Step 1. Clarification of unknown terms	
LST: laterally spreading tumor	
Step 2. Questions raised by the case	
What is an LST?	
What are steps in endoscopic diagnosis and treatment of an LST?	
What is the role of chromoendoscopy in the diagnosis of an LST?	
What is the endoscopic Kudo classification of an LST?	
What is the Kudo pit-pattern classification?	
How do you estimate the risk of submucosal invasion?	
What is the therapy of choice based on the risk of submucosal invasion?	
Do you need to take biopsy specimens before resection?	
What skills do you need to develop to perform endoscopic resection of an LST?	
What materials and equipment are required for resection of an LST?	
What are practical steps in endoscopic resection of LSTs?	
What is the surveillance recommendation in this patient?	
Step 3. Brainstorm	
Screening for colorectal cancer: 55–75 years, options: colonoscopy, fecal immunochemical test	
LSTs are technically difficult to resect endoscopically.	
LSTs have a high risk of submucosal invasion.	
Incomplete resection of an LST can lead to post-colonoscopy cancer.	
Effective endoscopic resection is mandatory.	
Endoscopic mucosal resection, endoscopic submucosal dissection, and surgery	
Experienced endoscopist	
Step 4. Learning goals	
How to assess the risk of submucosal invasion in the LST.	
How to ascertain the best therapeutic option.	
How to perform endoscopic resection of an LST.	
Step 5. Clustering	
Two main topics to study: LSTs and endoscopic resection techniques	
Step 6. Individual research	
The mentor may give advice regarding literature.	
Trainees perform an extensive search and read the most relevant references.	
Step 7. Discussion	
Second meeting	
The learning goals are discussed.	
If some topics need to be highlighted, the mentor can raise these in discussion.	

A summary of the discussion can be digitally shared.

After discussion, a new case is provided.

LST, Laterally spreading tumor.

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TABLE 4.**An example of problem-based learning**

A 68-year-old man with hypertension, diabetes mellitus type 2 and asthma was referred for a screening colonoscopy. The patient participated in an FIT-based national screening program for colorectal cancer. He had a positive test. His medication consists of metformin, digoxin, glimepiride, and antihypertensive medication.	
During the colonoscopy, 6 polyps were removed. Polypectomy of a large polyp in the sigmoid colon led to arterial bleeding, which was stopped by using argon plasma coagulation and hemoclips. Histopathology showed tubular adenomas with low-grade dysplasia. Because there was a limited inspection of the distal colon due to the bleeding, a repeat colonoscopy was performed. During this colonoscopy, 5 additional polyps were removed, which were tubular adenomas with low-grade dysplasia. The patient was recommended to undergo surveillance colonoscopy at 1 year and 3 years after the index examination. Each examination showed additional tubular adenomas with low-grade dysplasia. Because of the large cumulative number of polyps, the patient was referred for genetic testing to rule out a polyposis syndrome. APC gene mutation and MUTYH gene mutation analyses results were negative.	
Step 1. Clarification of unknown terms	
FIT: fecal immunochemical test	
APC: argon plasma coagulation: treatment for bleeding	
APC mutation: adenomatous polyposis coli gene mutation leading to an autosomal recessive polyposis syndrome	
MUTYH: a base excision repair gene that plays a significant role in detecting and protecting against oxidative DNA damage, leading to an autosomal recessive polyposis syndrome	
Step 2. Questions raised by the case	
What are familial syndromes associated with the occurrence of colorectal cancer?	
What is the rationale of screening for colorectal cancer?	
How is a national screening program organized?	
What is FIT testing? What is the sensitivity and specificity of FIT?	
What is the risk of bleeding after polypectomy?	
What are risk factors for bleeding after polypectomy?	
How is post-polypectomy bleeding managed?	
Step 3. Brainstorm	
National screening program: age 55–75 years, primary test: FIT every 2 years	
High specificity >90%	
Symptoms of colorectal cancer: Blood per rectum, anemia, fatigue, weight loss	
Adenomas with high-grade dysplasia turn into cancer sooner. Different mutations can lead to a higher grade of dysplasia or ingrowth of the tumor into deeper layers of the colon wall.	
Different types of adenomas: villous vs tubular adenoma. Pedunculated or sessile polyps	
Different classifications for histopathology and morphology	
Treatment of bleeding in this case: epinephrine, APC, hemostatic clips	
Hereditary causes for colorectal cancer: Different mutation pathways exist. APC gene, p53 gene mutations, familial syndromes: familial adenomatous polyposis, Lynch syndrome (hereditary nonpolyposis colorectal cancer)	
During the brainstorm, it was found that the trainees were already well-informed about the national screening program.	
Step 4. Learning goals	
What are stages in progression of colorectal adenomas to colorectal cancer?	
What are the main genetic events in colorectal cancer progression?	
What are polyp factors associated with increased risk of progression to colorectal cancer?	
What are polyposis syndromes? What are the diagnostic criteria for attenuated familial adenomatous polyposis? What are the diagnostic criteria for MUTYH-associated polyposis?	
What are the possible adverse events of colonoscopy? What are risk factors for bleeding after polypectomy?	

How to manage post-polypectomy bleeding

Step 5. Clustering

Three main topics: colorectal cancer progression, polyposis syndromes, and adverse events

Step 6. Individual research

The mentor may provide advice regarding literature

Trainees perform extensive searches and read the most relevant references

Step 7. Discussion

Second meeting

The learning goals are discussed

After discussion, a new case is provided

FTT, Fecal immunochemical test.

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