Teaching Primary Care Genetics: A Randomized Controlled Trial Comparison

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BACKGROUND AND OBJECTIVE: Given the increasing discussions of the impact of genetic medicine within family medicine, it is important to determine the most effective way of teaching this material to family medicine residents (FMRs). The objective of this study was to evaluate and compare the impact of three methods of delivering primary care genetic content to FMRs.

METHODS: Curriculum materials and assessment tools were created to teach and evaluate knowledge, skills, and attitudes around four core competencies in primary care genetics, with a focus on hereditary colorectal cancer (CRC). Participants were randomly allocated to four learning conditions: (1) no intervention (control), (2) web-based module outlining genetic concepts applied to CRC, (3) live presentation of the web-based material, (4) live presentation and subsequent standardized patient (SP) encounter. Three months later, all participants completed a written knowledge test, attitude survey, and a standardized patient-based performance assessment.

RESULTS: Sixty FMRs completed the study. All three educational interventions resulted in significantly improved outcome measures in knowledge and skills but not attitudes, compared to control. There was no significant difference in outcomes between intervention groups.

CONCLUSION: FMRs acquired knowledge and improved skills in genetic medicine with three educational methods. Resources such as faculty expertise in genetic medicine and cost should guide decisions on curricular development for this rapidly expanding field. This may be especially relevant for programs with distributed teaching sites.

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Advances in genetic medicine are increasingly influencing clinical care. Family physicians have an important role in identifying patients at increased risk for genetic diseases and enabling them to make informed choices about the appropriateness and value of genetic testing. Evidence suggests that although the number of family physician/patient discussions about genetics is rising, family physicians are not equipped with the knowledge and skills to fully respond to these demands.[1-4] Studies of family physicians indicate poor skills in evaluating family history for genetic conditions, missed opportunities for genetic diagnosis, as well as a lack of awareness and few referrals to genetic counseling services.[1]

Previous research involving focus groups with family medicine residents (FMRs) who had graduated from Canadian medical schools revealed that their experiences with genetics education in undergraduate medical school were limited to learning about rare disorders.[5] They felt that genetics would be important to their future clinical practices, but they did not have the knowledge or skills to address this area. FMRs wanted ready access to genetic information that was relevant, up to date, practical, and focused on real

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patient scenarios. A study of academic family physician teachers found that they also had low knowledge of genetic testing and counseling.[6] While these faculty teachers felt that genetic testing had value in primary care, they lacked confidence in their knowledge and skills in this area.

In considering the development of educational resources for primary care genetic teaching, it is important to note the unique biologic and biopsychosocial concepts in genetics that may require a range of teaching methodologies (for example, the effect of genetic testing on family members, which has distinct psychosocial, ethical, and legal implications).

Didactic learning is a traditional teaching method in medical education and allows for direct interaction with the instructor. Some literature demonstrates poor retention for didactic sessions,[7] and conversely other studies demonstrate positive outcomes.[8] Web-based learning is efficient, easy to disseminate, flexible in time and location, and increasingly used in medical education. However, caution has been noted in designing web-based learning to ensure that learner outcomes are met. Standardized patient (SP) methodologies have been integrated into medical education for many years. Benefits of direct patient experience, especially in addressing sensitive issues, have been shown.[9,10] Feedback from SPs to medical trainees is also highly valued.[11] Experiential learning with SPs provides learners with an opportunity to develop and refine their knowledge and communication skills.[12] SPs are resource-heavy financially, in personnel and space requirements. Questions remain as to whether this methodology is superior for knowledge acquisition. While many studies have assessed these different methods of teaching, few have directly compared their effectiveness, and none have evaluated them in teaching primary care genetics to FMRs. Our hypothesis was that the more intense intervention of a didactic session followed by SP interactive role scenario would be more effective for teaching primary care genetics knowledge and competencies.

The overall goal of this study was to inform the development of a curriculum in primary care genetics for FMRs. This curriculum would address the core competencies of taking a three-generation family history, assessing risk for hereditary cancers, offering referral for genetic counseling where appropriate, and understanding benefits, risks, and limitations of genetic testing. The objectives were to evaluate and directly compare the impact of three methods of delivering primary care genetic content (web-based learning, didactic learning, didactic learning plus interactive SP experience) on knowledge, skills, and attitudes around these four core competencies in primary care genetics for FMRs.

Methods

This study used a four arm prospective randomized controlled trial with a post-intervention assessment design. It was implemented over 2 years in order to obtain a sufficient sample size. Prior to embarking on the trial, we developed the core competencies of the curriculum, an educational module, SP module, and post-intervention outcome measures. Research ethics approval was received from the University of Toronto Research Ethics Board.

Determining the Core Competencies of Our Curriculum Template

Based on our previous study[5] and the recommendations from the National Coalition for Health Professional Education in Genetics,[13] the research team determined four core competencies for a primary care genetics curriculum template. As well as including broad primary care genetics competencies, we included some that focused on hereditary colorectal cancer (CRC) as this was our chosen case example. The core competencies were: (1) taking a three-generation family history, (2) assessing risk for hereditary cancers, particularly CRC, (3) offering appropriate referral for genetic counseling, and (4) understanding the benefits, risks, and limitations of genetic testing, including the accompanying ethical, legal, and social issues. Relevant knowledge, skills, and attitudes were identified for each competency (Table 1).

Development of the Educational Module

A slide set previously developed for a CRC educational program for practicing primary care providers[14] was used for this project. A genetic counselor updated the content of two of the slides on genetic testing for CRC, and several slides were inserted at the beginning of the program to review the general principles of family history-taking and approach to the high-risk patient that would be appropriate for family medicine trainees.

A didactic session was developed to accompany the slides. To create the online version of the educational module, one of the investigators (JC) was video-recorded as she lectured using the same slides. The video recording was then uploaded to a password protected web site.

Development of a Standardized Patient Scenario and Simulated Office Oral Examination (Group 4)

The investigator team created an SP scenario about a patient at high risk for hereditary colorectal cancer presenting for the first time to his family physician. The scenario included a detailed history of the patient's presenting concern (his father recently diagnosed with colon cancer), his family history, and social history. The scenario was piloted with two volunteer second-year FMRs. Modifications were made to the patient scenario based on this pilot.

Development of Post-Intervention Outcomes Measures

Each of the four competencies was measured in each of three separate assessment tools designed to test

Table 1: Description of the Four Selected Competencies and the Associated Knowledge, Skills and Attitudes Selected for the Objectives in the Educational Module and Assessments in the Study

I. Taking a family history (three generation)
Knowledge:
1. Understand the importance of family history (minimum 3 generations) in assessing predisposition to disease.
Skill:
1. Gather cancer family history information, including an appropriate multigenerational family history.
II. Assessing risk for hereditary colorectal cancer
Knowledge:
1. Understand how identification of disease-associated genetic variations facilitates development of prevention, diagnosis and treatment options.
2. Understand the indications for genetic testing and/or gene-based interventions.
Skills:
1. Identify patients who would benefit from genetic services.
III. Offering referral to genetic counseling
Knowledge:
1. Understand the components of the genetic counseling process and the indications for referral to genetic specialists.
Skills:
1. Seek assistance from and refer to appropriate genetics experts and peer support resources.
2. Educate patients about availability of genetic testing and/or treatment for conditions seen frequently in practice.
Attitudes:
1. Seek coordination and collaboration with interdisciplinary team of health professionals.
2. Recognize the limitations of their own genetic expertise.
IV. Understanding the benefits, risks, limitations of genetic testing, including the ethical, legal, social issues that accompany genetic testing.
Knowledge:
1. Understand the potential physical and/or psychological benefits, limitations and risks of genetic information for individuals, family members and communities.
2. Understand the ethical, legal and social issues related to genetic testing and recording of genetic information (eg privacy, potential discrimination in health insurance and employment)
Skills:
1. Provide appropriate information about the potential risks, benefits, and limitations of genetic testing.
2. Educate patients about the range of emotional effects they and/or family members may experience as a result of receiving genetic information.
Attitudes:
1. Appreciate the sensitivity of genetic information and the need for privacy and confidentiality.

knowledge, attitudes, and skills respectively (see Table 2).

A written knowledge test was developed to cover the specified competencies. The test included six true/false questions, six knowledge-based multiple-choice questions (MCQs), three short cases with subsequent MCQs (total of 13 questions), and eight short answer questions, which were scored either correct or incorrect. Thus, the maximum score on the knowledge test was 33. The test was piloted on several practicing family physicians, and modifications were made based on their suggestions.

An attitude survey was developed and asked participants to select either agree, disagree, or unsure to seven statements about the importance and value of family history in patient care and the role of genetic counseling and testing in practice. Each item was scored a 1 if the participant agreed with statements consistent with the objectives of the course or disagreed with inconsistent statements and was scored as 0 otherwise. As well, participants were asked to respond to four statements regarding their attitudes toward genetic testing and counseling about CRC using a 5-point Likert scale (strongly disagree to strongly agree). For the purpose of scoring, items

Table 2: Breakdown of Scoring for Each Competency Across Each Assessment Format

Objectives	Written Knowledge	Attitude Scale	Standardized Patient	Total
Family history	1	1	6	8
Risk assessment	20	1	12	33
Referral for genetic counseling	5	4	4	13
Understanding risks and benefits	7	5	5	17
Total	33	11	27	71

Each of the four competencies identified in column 1 (objectives) was evaluated in three different assessment formats (written knowledge, attitude scale, and standardized patient). The cells in columns 2, 3, and 4 represent the number of items that were relevant to each competency in each test format. Thus, the number of items in the final (Total) column represent the number of items used in the calculation of the score for each format.

rated as agree or strongly agree on this scale were given a score of 1, and all other responses were given a score of 0. Thus the total possible score for the attitude assessment was 11.

To assess performance skills, the investigators developed a second SP scenario to evaluate the application of knowledge and clinical skills. This scenario also involved a patient at high risk for CRC presenting to a family physician for the first time; however, the patient's demographics, family history, and psychosocial issues were different from those of the Group 4 intervention group. Each participant performance was marked by one of four of the investigators, who observed the interaction through a one-way mirror. To minimize bias, the participants were not evaluated by investigators who had been part of their interactive-SP learning experience or from their own teaching site. Scoring of the SP interaction was based on the model of the simulated office oral (SOO) used by the College of Family Physicians of Canada in its examination for specialist certification. The SOO captured performance in: taking a family history and history of the illness, identifying the patient as at high risk of CRC, taking a social history discussing the patient's risk and suggestions for colonoscopy, referring to genetic counselling and interviewing. Again, consistent with the SOO model, there was a set of items that totaled 9 points for a total possible score of 54 in each section. Across the six sections for this SP encounter, there were 30 items with possible scores on each item ranging from 1 to 4, depending on complexity of the item being scored (1 [17 items], 2 [4 items], 3 [7 items] or 4 [2 items]). Fifteen of the 30 items, a total score of 27, were relevant to one of the four competencies.

Table 2 presents the breakdown of scoring points for each competency across the three outcome measures. For analysis, participants' total scores for each measure and for each objective were converted to percent values.

A survey instrument was developed to obtain feedback on educational materials and the participants' learning experiences. This survey asked participants in each group if they found their method of learning effective, if they would like to learn other topics in this way, and if they would recommend this educational method to a colleague. As well, free text answers to benefits and drawbacks of the learning method and general comments were included.

Details of the Randomized Controlled Study

Two consecutive cohorts of first-year FMRs at University of Toronto (each 100 FMRs) were invited via email to participate. Informed consent was obtained. Participants were compensated with $100 for their time. Participants were randomized to four groups: control, web-based, didactic, and didactic plus standardized patient interaction.

Group 1 acted as a control and received no specific genetics educational intervention. Participants were informed that they would have access to the study materials after the study was completed. Group 2 was given access to the self-study web-based lecture module for a 3-week period. Each participant had his or her own anonymized login name and password. They were given a contact email where they could ask questions, which were answered by the primary care genetics expert or the genetic counselor.

Groups 3 and 4 received a 1-hour didactic lecture similar to that seen online by Group 2 (using the same slide set), plus question and answer session led by one of the investigators (JC). Immediately after the lecture and discussion session, Group 4 was divided into small groups of six, with two facilitators from the investigator team, for the 1-hour interactive SP encounter. Each participant took a turn interviewing the SP while being observed by the others. They received immediate feedback from the SP, the facilitators, and fellow group members.

Three months following the intervention, participants in all four groups completed the post-intervention assessments, including the knowledge test, attitude survey, SP encounter, and the survey evaluating the educational experience.

Data Analysis

Analysis of the data involved two separate two-way mixed design ANOVAs. The first ANOVA used training group (ie, type of educational intervention) as the between-subjects variable and examination format (written knowledge, attitude scale, SP encounter) as the within-subjects variable. The second ANOVA used training group as the between-subjects variable and objective as the within-subjects variable. When there was a significant effect of group, post-hoc analyses were used to determine where differences lay among groups. For all analyses, percent scores were used to facilitate comparisons across tests and across objectives. All descriptive and inferential statistics were calculated using SPSS v.23 (IBM).

Results

Sixty-seven first-year FMRs agreed to participate in the study, and 60 residents (32 from the first cohort and 28 from the second cohort) completed the study with full data sets. There were 15 participants in the control group, 14 in the web-based group, 16 in the didactic group, and 15 in the didactic + SP group.

Outcome Regarding Knowledge, Skills, and Attitudes (Figure 1)

The two-way ANOVA examining the effect of examination format and group on score revealed a significant main effect of group ($F_{3,56}$=4.76, P<.01), a significant main effect of examination format ($F_{2,112}$=49.50, P<.001), and a significant group by format interaction ($F_{6,112}$=2.56, P<.05). Subsequent one-way ANOVAs examining each of the examination formats separately revealed a significant effect of group for the written knowledge test ($F_{3,56}$=13.49, P<.001) and for the SP interaction ($F_{3,56}$=4.74, P<.01). For each of these formats, subsequent post hoc analyses revealed that the control group scored significantly lower than each of the three intervention groups but that none of the intervention groups was significantly different from the others. The ANOVAs revealed no significant differences among groups for the attitude subscale ($F_{3,56}$=0.35, ns).

Outcome on Core Competency Subscales (Figure 2)

Examining each of the competency subscales separately (collapsing across the knowledge, attitude, and performance measures), the two-way ANOVA revealed a significant effect of group ($F_{3,56}$=7.12, P<.001) and a significant effect of competency ($F_{3,168}$=18.04, P<.001) but no group by competency interaction ($F_{9,168}$=0.66, ns). Subsequent post hoc comparisons revealed that across competencies, the control group scores were significantly lower than each of the intervention groups, but that none of the intervention groups was significantly different from each other.

Participants' Report of Their Experience

Post hoc analysis of comments made by FMRs revealed that almost all

Figure 1: Performance of the Four Groups (Percent of Possible Total Score) for Each of the Three Assessment Formats Collapsed Across the Four Assessed Competencies

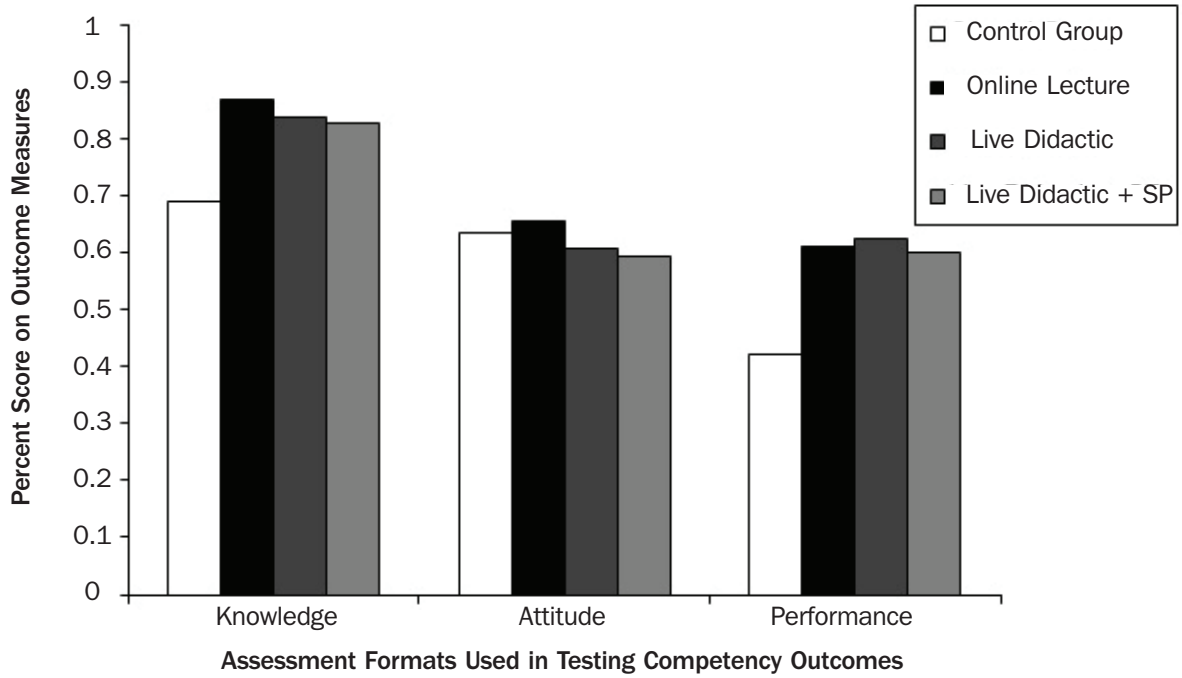
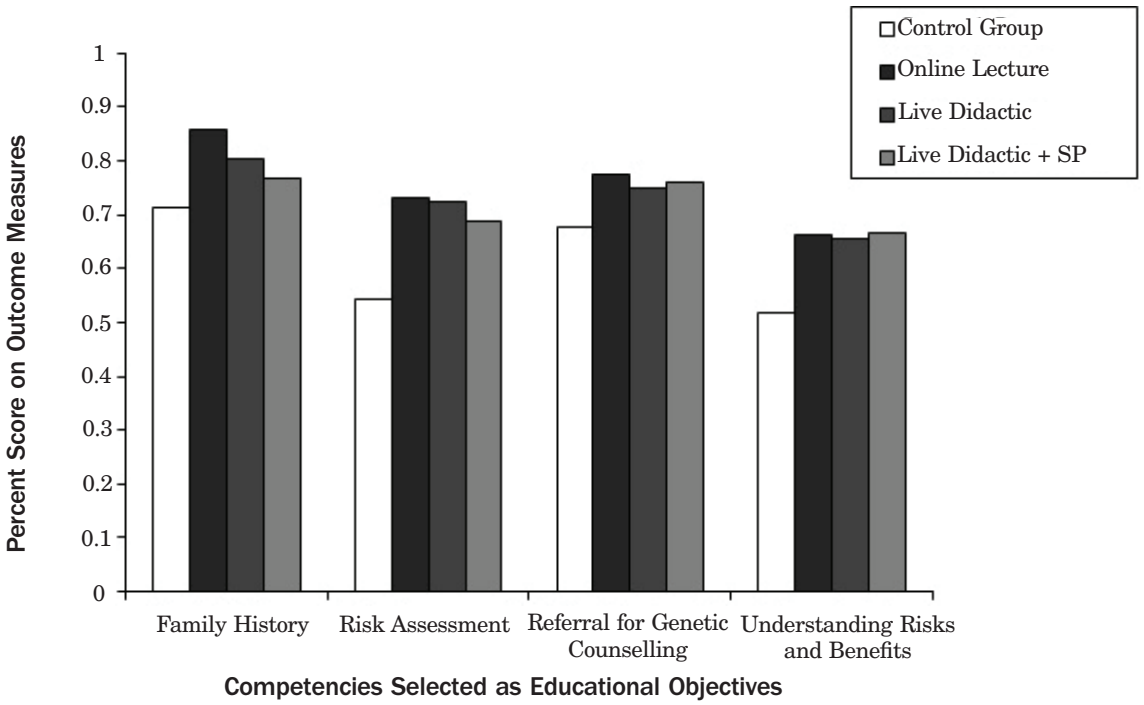


Figure 2: Performance of the Four Groups (Percent of Possible Total Score) on Each of the Four Competencies Collapsed Across Assessment Formats



participants in each intervention group stated that their specific educational method was effective. Most of the comments were quite general (such as "good learning experience," "enjoyed the process"). The web-based group appreciated the convenience of learning on their own time and at their own pace and location, as well as the ability to replay parts of the lecture as needed. They stated that the downside of this method of learning was the lack of group interaction for discussion. Group 4 (lecture + SP interactive scenario) stated that this was an "ideal way to learn" as the experience allowed them to put "knowledge into practice" by applying what they learned in a standardized setting and that this was immensely helpful in consolidating knowledge and skills. Immediate feedback on interviewing skills by the facilitator and SP was suggested as something that should be incorporated into more aspects of residency training.

Discussion

This study was the first of its kind to directly compare different methods of teaching primary care genetics to FMRs. Our study demonstrated that all three educational interventions enabled FMRs to acquire knowledge and skills in genetics with no difference between teaching methods. Consistent with our findings, a systematic review of e-learning for undergraduate health professional education[15] concluded that "both computer-based and web-based e-learning is no better and no worse than traditional learning with regards to knowledge and skill acquisition," and a meta-analysis[16] found minimal improvement of web- based learning compared to traditional methods in health professional education. Each educational method has advantages (ease of administration, opportunity to learn at one's own time/place, opportunity to practice skills, participant perception of educational value) and disadvantages (cost, resources, isolated learning).

Due to increased enrolment in family medicine training programs and funding challenges, and the clear lack of faculty expertise in this area,[6] developing and disseminating web-based learning modules in primary care genetics may be the most cost-effective way, in terms of faculty and resources required, to teach these skills. Many family medicine teaching sites are distributed over a large distance. Having access to web-based learning would greatly facilitate dissemination of this teaching material, especially in areas without primary care genetics expertise.

The Group 4 intervention which included a SP patient scenario, group discussion, and direct and immediate facilitator feedback to trainees, was evaluated highly. However, we were surprised to discover that this did not lead to any improvements on the subsequent SP scenario at

test. Whether this was because of the long delay between the training and test or whether a single interaction with an SP in training was insufficient to engender specific educational benefit in patient skills in this area is unclear. Experiential learning with SPs was clearly valued by the residents. Our findings suggest that further use of this teaching method in curriculum design to teach the basic concepts and skills of primary care genetics should be evaluated, especially in areas where needs assessments identify gaps in clinical skills, rather than solely gaps in knowledge.

There were a number of limitations of our study. Small sample size may account for no significant difference in outcomes between the intervention groups. Recruiting trainees was challenging, which may have been partly due to the significant time commitment involved and that trainees had to commit to participating before knowing which group they would be in. The SOO is a validated evaluation tool used in family medicine certification in Canada. The knowledge test used in the study was developed specifically for this study, and therefore we do not have any independent determination of its reliability or validity. Although the knowledge and performance tests were clearly able to discriminate those who received an intervention from those who did not (suggesting some construct validity), the lack of independent determinations of reliability or validity outside the context of the study place some limits on our interpretation of the results. In this study, we used a one-time educational intervention: perhaps a longitudinal study design would tease out differences in knowledge, skills, and attitudes acquired using the different educational methods. This may have significant impact on the SP experience: key educational theories (including experiential learning, expertise, situated learning) suggest that deeper learning of these complex situations requires time for assimilation. Several exposures to an SP experience may teach and refine skills over time[17,18] that could not be captured in this study. Also, this study was conducted with CRC as the prototype learning module—it would be interesting to see if results remained consistent with a primary care genetics curriculum containing additional modules.

This study contributes importantly to the small body of literature on effective methods for educating primary care providers[19-24] and postgraduate trainees in primary care genetics.[25] Previous studies, mostly geared to practicing family physicians, assessed knowledge pre- and post-educational interventions but did not assess skill. One study[25] evaluated the difference in knowledge and risk assessment for CRC among internal medicine trainees assigned to a didactic lecture, or a didactic lecture, case-based seminar and Personal Digital Assistant-based risk assessment tool. They found the latter method increased knowledge but had no effect on risk assessment skills. Our study demonstrated that all three methods of delivering this content were effective and could be implemented in primary care genetics curriculum design, depending on local factors. All three educational methods could easily be kept up to date with advancing primary genetic knowledge.

Our study showed that there are benefits to didactic teaching, web-based learning, and SP scenario encounters with feedback in the design of a primary care genetics curriculum. A one-time intervention increased knowledge and skills in primary care genetics. Factors including resources such as cost, faculty expertise, SP access, and distance between learners should guide decisions on curricular development for this rapidly expanding field of primary care genetics. Comparing different formats within web-based learning, such as synchronous/asynchronous and group versus individual learning, should be evaluated. Further evaluation of these teaching methods in delivering primary care genetics curriculum to FMRs, with more content topics and over a longitudinal time period, is necessary.

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