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***The SMARxT Media Literacy Program:  
Improving Evidence-Based Prescribing among Medical  
Students***

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**ABSTRACT**

Media literacy may help medical trainees optimize evidence-based decision-making. Many prescriptions written are not evidence-based, resulting in unnecessary morbidity and mortality. In this study, we aimed to assess feasibility, acceptability, and initial efficacy of a media literacy prescribing program. We recruited 30 medical students, 70% of whom completed animated video modules about pharmaceutical marketing and prescribing and all assessment activities. We used process evaluation and open-ended items to assess feasibility and acceptability, and we used knowledge tests before and after the intervention to assess efficacy. The program was feasible to implement and well-accepted by participants. After the educational intervention, knowledge and attitude targets around evidence-based prescribing and drug marketing improved.

**Keywords:** *media literacy, evidence-based prescribing, SMARxT, medical education*

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Evidence-based prescribing (EBP) can be defined as “prescribing practices that involve the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients” (Sackett et al. 1996). However, a substantial proportion of the 3 billion prescriptions written annually are not evidence-based (U.S. Food and Drug Administration 2012; Curtis et al. 2004; Hersh et al. 2011; Eguale et al. 2012), which results in

unnecessary morbidity and mortality (Zgierska, Miller, and Rabago 2012; Budnitz et al. 2007) and contributes to rising healthcare costs (Ernst and Grizzle 2001).

In the U.S. alone, costs from drug-related problems, such as adverse drug reactions and increased hospitalizations, total over \$30.1 billion annually and are continuing to increase (Sultana, Cutroneo, and Trifiro 2013). Although the contributors to non-evidence-based prescribing in the U.S. are multifaceted, the multi-billion-dollar marketing of prescription drugs to patients and physicians (Donohue, Cevasco, and Rosenthal 2007; Gahart et al. 2003; Gellad and Lyles 2007) strongly influences both patient requests for medications (Gilbody, Wilson, and Watt 2005; Robinson et al. 2004; Shah et al. 2005; Kravitz et al. 2005) and provider prescribing habits (Gilbody, Wilson, and Watt 2005; Kravitz et al. 2005; Donohue et al. 2004; Lewis 2003). With limits being placed on interactions between physicians and pharmaceutical representatives (Fugh-Berman et al. 2011; Evans et al. 2011; Grande 2010), point-of-care health information technology (HIT) has been increasingly used to reach providers (Iskowitz 2010; Montoya 2008). For example, 85% of physicians use smartphones or medical applications (“apps”) to assist with prescribing choices (Wilson 2011). The most commonly used free medical apps are funded in large part by pharmaceutical company in-app advertising (Wilson 2011) and may contribute to non-EBP.

The World Health Organization cites the need for physicians to analyze pharmaceutical marketing practices as part of their prescribing process in their *Guide to Good Prescribing* manual (de Vries et al. 1994). To our knowledge no systematic training programs exist that rigorously address this need, although some medical schools and residency training programs have developed promising programs about the pharmaceutical industry specifically for their students (Wilkes and Hoffman 2001; Wofford and Ohl 2005; Montague, Fortin, and Rosenbaum 2008; Wall et al. 2013). Thus, we thought it would be valuable to build on this prior work to develop a comprehensive, conceptually-based educational intervention that can be easily integrated into a variety of training curricula.

Media literacy is a promising paradigm for the development of educational programs such as these. It encourages analysis and evaluation of media messages, such as advertisements, in order to create active participants in the communication process rather than passive targets (Brown 2006; McCannon 2005; Potter 1998; Buckingham 2003). Media literacy has been successfully used to buffer the negative influence of media messages on health-related topics such as substance abuse (Pinkleton et al. 2007; Primack et al. 2006; Primack et al. 2009; Gordon, Jones, and Kervin 2015), violence (American Academy of Pediatrics 2009; Comer et al. 2008; Worthen 2007), and eating behaviors (Wade, Davidson, and O’Dea 2003; Wadsworth and Thompson 2005; Wilksch, Durbridge, and Wade 2008; Liao et al. 2016; Hobbs et al. 2006). However, to our knowledge it has not been sufficiently used to reduce the influence of pharmaceutical messaging on EBP (Bergsma and Carney 2008). Therefore, we

developed an intervention entitled “SMARxT” for the purpose of leveraging media literacy to optimize patient communication and EBP decision-making.

The overarching goal of this project was to conduct initial testing of this program for medical students. Our specific aims were two-fold: (1) to determine the feasibility and acceptability of the SMARxT program, and (2) to determine the efficacy of the program at increasing knowledge about pharmaceutical marketing practices as they relate to EBP. We hypothesized that the program would be feasible to complete (H1a) and well liked among the participants (H1b). We also hypothesized that, after exposure to the curriculum, participants would have significantly increased knowledge of the topics covered in the video modules (H2).

## METHODS

### Design and Participants

We designed and implemented an evidence-based program based on the principles of media literacy called SMARxT. We selected a mixed methods approach (qualitative and quantitative) in order to optimally evaluate our two aims. While qualitative analysis was more appropriate for assessing program feasibility and acceptability, quantitative methods were employed to address program efficacy.

We recruited medical students currently enrolled at the University of Pittsburgh School of Medicine. At the time of recruitment, the school enrolled approximately 600 medical students, with about 150 students per class. Students from all four years of the medical program were eligible, except for students in non-clinical programs (e.g., MD-PhD students currently focusing on their PhD work). This was because we wished to focus on our target audience of students focusing on clinical matters.

Participants were a convenience sample of the first 30 eligible medical students who responded with interest to an email advertising the study. This number was selected based on established guidelines for similar pilot studies; while 10-30 participants are suggested, we wished to err on the higher side of this estimate (Hertzog 2008; Isaac and Michael 1995).

### Intervention

SMARxT is based on the principles of media literacy. The purpose of the program is to improve evidence-based prescribing among medical professionals (students and residents). It aims to accomplish this by promoting critical thinking around pharmaceutical marketing and its potential influence on the patient-provider relationship. A local leader in educational curriculum development called Simcoach Games assisted with multiple aspects of the program, including conceptual mapping, curriculum development, artistic design, animation, sound engineering, and user interface (Trybus, n.d.). The program centers on conversations between two medical trainees who discuss various issues around pharmaceutical marketing as it relates to patient care. One trainee is a senior resident who is sophisticated around these issues, while the

other trainee is a less-experienced but observant first-year. In order to engage learners, various strategies were employed in the selection and development of content, including compelling visuals, practical case studies originating from clinical practice, use of humor, and a conversational style between the characters.

The program was structured around the mnemonic “SMARxT,” each letter of which describes one key strategy we wished to impart: “Simplify Prescription Regimens,” “Master Marketing,” “Ally with the Patient,” “Read Critically” (both published literature and persuasive messages such as advertisements), and “Take Advantage of Tools.” As **Table 1** shows, the program consisted of six video modules, an introduction module followed by one module focusing on each of the key strategies. Each video ranges from 10-15 minutes in length, for a total of about two hours. A complete outline of the SMARxT program, including scripts, is available from the authors upon request and completion of a non-disclosure agreement.

This program was designed to specifically target medical students and residents due to the fact that this is a population that is vulnerable to pharmaceutical messages (Zipkin and Steinman 2005; Sarikaya, Civaner, and Vatansever 2009). Additionally, these individuals are at a time of training during which they tend to solidify their prescribing habits and drug preferences (Bjornsdottir, Kristinsson, and Hansen 2010).

**Table 1**  
**SMARxT Program Module Descriptions**

<b>Module Abbreviation</b>	<b>Module Title</b>	<b>Module Description</b>
I	Introduction	Summaries introducing examples of each SMARxT module topic. Emphasis is on the importance of the topic and implications for quality care.
S	Simplify	Material related to simplification of treatment plans through the use of lifestyle modifications, time-tested generic medications, and avoiding “me-too” drugs or unnecessary adjuncts.
M	Master Marketing	Identification and description of various pharmaceutical marketing techniques used in direct-to-consumer and physician advertising.
A	Ally	Modeling of skills for mitigating patient drug requests and creating opportunity for patient education. Emphasis is placed on using requests to deepen and improve the patient-provider relationship instead of putting strain on it.

Rx	Read Critically	Explication of ways to critically assess potentially biased medical information. This includes not only information directly from industry but also information which may have been influenced, such as articles in medical journals and formulary medications.
T	Tools	Discussion of valuable tools (e.g., Web sites and apps) for supporting evidence-based prescribing. Also emphasized are methods for evaluating the quality of Web-based tools which may or may not be biased.

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### Procedures

We obtained approval from the medical school and the Institutional Review Board of the University of Pittsburgh. An email was sent out to all medical students briefly describing the SMARxT program and asking for participants. After 30 interested students responded, enrollment was closed and limited to these individuals. Participants received individual program Web links that allowed them to complete the program at their own time and pace. Reminder emails were sent out weekly over four weeks. Students who completed the study were compensated \$40 in appreciation of their time. We deemed this amount to be sufficient recompense for effort in this population but not enough to be coercive.

### Measures

We developed measures based on the aims of this study: first, to explore the feasibility and acceptability of the educational intervention and secondly, to examine its efficacy in meeting educational objectives. In assessing the first aim of this study, feasibility and acceptability, we used two different measures. The first was a quantitative measurement, assessing participants' attitudes towards the program. An 11-point Likert-type scale was used, ranging from strongly disagree (0) to strongly agree (10). Six items centered around whether the students found the program entertaining, informative, reasonable in terms of test questions, knowledge-enhancing, and recommendation-worthy for other students and residents (2 items). These were presented to the students at completion of the study.

For the second measurement, at the end of the study, all students were asked two open ended questions. The first item asked what the students found most valuable about the program. The second item requested feedback from the participants on what could be improved about the program. Students were asked to be as specific as possible in their comments.

We also asked students at the end of the program to estimate what percentage of the videos they watched using a sliding scale ranging from 0 to 100% in 1% increments. We asked participants to rate how focused they were while watching the videos on the following 4-point Likert-type scale: very distracted, somewhat distracted, somewhat attentive, and very attentive.

For the second aim of the study, efficacy, we used identical pre- and post-test multiple choice questions to assess changes in knowledge. We selected the multiple-choice format in order to mirror the way that medical students are assessed in other established settings, such as in the United States Medical Licensing Examination (USMLE). We adhered to specific formatting requirements of USMLE items. For example, all multiple-choice items had exactly 5 possible responses, and there was only one correct answer to each question (i.e., there were no “all of the above” style responses). We adhered to these guidelines because substantial research has confirmed the value of this formatting for factual assessment items in this population (Swanson et al. 2005).

The items were developed by the study team using an in-depth iterative process. Initially, several in-person meetings resulted in over one hundred multiple choice questions, which were based directly on program objectives. Subsequent meetings focusing on honing the items and eliminating items with potentially ambiguous responses resulted in a final pool of 62 items. Questions were divided among the six modules, with each section containing nine to eleven questions. Each module had questions designed to test knowledge specifically related to the content of the respective video. Assessment questions and responses were designed to be accurate and consistent with current medical practices and knowledge. All correct question responses were required to be supported by published literature. An experienced psychometrician oversaw this project component and helped create, review, and finalize the set of questions.

### **Data Analysis**

We primarily used histograms to examine participants’ post-test attitudes towards the program. We selected this method to provide a nuanced and transparent view of students’ responses that cannot be achieved with measures of central tendency alone. However, we also computed mean, median, and mode for each item.

We also summarized the percentage of videos students reported watching. Similarly, we examined descriptive data around focus and attentiveness while watching the videos according to the four provided responses (i.e., very distracted, somewhat distracted, somewhat attentive, or very attentive).

In assessing the open-ended items, we used an iterative thematic analysis. All main study team members read all comments from the students. Team members then met on three separate occasions to create and refine a codebook summarizing recurring themes. We used a tabular format to display major themes and specific examples of comments from participants representing each of the themes.

We examined pre- and post-test differences in number of correct answers using histograms, medians, and interquartile ranges. Medians and interquartile ranges were superior to means and standard deviations because of the non-normal distribution of data. We assessed the statistical significance of these differences using the Wilcoxon-pairs signed-rank test. We also repeated all of these analyses while stratifying for the program component (e.g., Simplify

vs. Master Marketing) to determine if some program components may have been more effective than others. We defined statistical significance with a two-tailed alpha of 0.05. Statistical analyses were performed in 2016 with Stata 13.1 (State Corp, College Station, Texas).

## RESULTS

Of the 30 individuals enrolled, 21 students (70%) completed the entire program, including all pre- and post-test assessment items. The majority (76%) were second-year medical students, while first-, third-, and fourth-year students represented 5%, 14%, and 5% of the responses, respectively. In terms of gender, 38% of participants were female, 62% male.

### **Aim 1: Feasibility and Acceptability**

Medical students had positive attitudes towards the program. **Figure 1** shows responses to all six attitude questions and this data reveal largely positive attitudes towards the various components of the program. Only one student gave the program occasional negative ratings. The most positive responses were towards learning new information from the program, as 76% of students responded 9 and above (strongly agree).

Students found the educational videos to be both entertaining and educational. When asked to rate the entertainment aspects of the videos, 60% rated it an 8 and above. The majority of students, 61%, also gave a 9 or above when asked if the videos were informative. When asked about the multiple-choice questions, 90% agreed that they were reasonable by rating 7 or above. Finally, 90% of students responded that they would recommend this program to other medical students and residents, with ratings of 7 or above and 6 or above, respectively, showing significant agreement with these statements.

When asked to respond to open-ended items, the medical students had many positive reactions to the program. Comments were consistent with three main themes. The first theme was that the program was educational. Students specifically commented that it was “eye-opening” and made them “more aware of the influence of pharmaceutical companies.” One student even went so far as to say that the SMARxT program “should be mandatory for student doctors.”

The second theme was that the program was simple to use. As **Table 2** shows, students stated that the videos were “short,” “easy to understand,” and an “easy way to learn new stuff.” The final recurring theme was the entertaining aspect of the program. Medical students found the program to be “clever” and reported how the “occasional jokes in the video helped [them] pay attention.”

The medical students had suggestions on how to improve the program. The most predominant comments were on the pace of the videos. Students remarked on how the videos could be increased to “1.5x to 2.0x speed.” Some even went so far as to say the current speed of the videos “was like watching paint dry.” Along with the thoughts on speed, some students recommended condensing some of the content due to the videos being “too long” and “repetitive.” Finally, as **Table 2** shows, there were several comments on the

design of some of the pre- and post- assessment questions. Some students stated that several of the questions were “difficult to answer” and “very particular.”

Medical students individually reported what percentage of the videos they watched, with values ranging from 27% to 100% of the videos being watched. The majority of students watched most or all the videos, with an average of 89% of the videos viewed. In terms of attentiveness to the videos, 19% of participants reported being very attentive, 48% were somewhat attentive, 29% were somewhat distracted, and <5% were very distracted. The mean time for survey completion was 11.9 days.

### **Aim 2: Efficacy**

Initial assessment of pre- and post-test items used histograms to determine if the data was normally distributed. Graphs showed that both pre- and post-test data were not normally distributed. Pre-test data had a bimodal distribution, while post-test data had a large negative skew (-0.66). Due to these findings and the small sample size of the study, the use of means and standard deviations was deemed unsuitable. All further analysis of the data was done using medians and interquartile ranges.

Pre-test knowledge before the intervention showed that students on average answered 24 questions correctly out of 62 (39%, IQR 22-27). After the intervention, students correctly answered 47 out of 62 questions (76%, IQR 43-50). Use of the Wilcoxon-pairs signed-rank test calculated that the difference in correctly answered questions between pre-test and post-test was statistically significant ( $P < 0.001$ ) with a Wilcoxon score of  $z = 4.02$ .

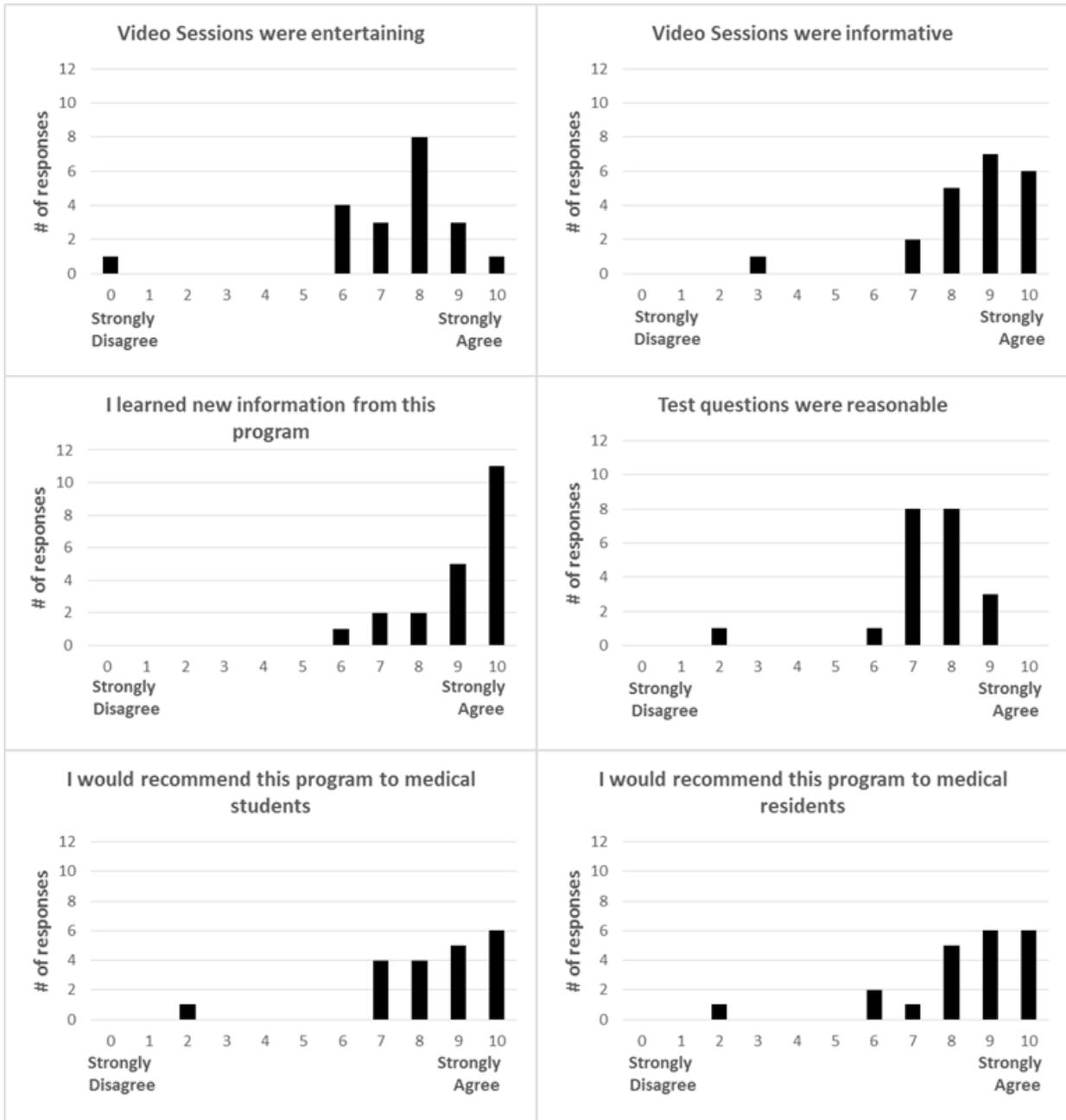
The pre- and post-test responses were also analyzed by each section of the SMARxT program. Average increase in percent correct responses on post-tests compared to pre-tests was 38% per video section. Significant improvement was seen in all sections of the program, except for the last section. Individually, the “Introduction” section had a 39% increase in correct responses, “Simplify” increased by 40%, “Master Marketing” by 45%, “Ally” by 50%, and “Read Critically” increased by 45%. “Tools” was the only section that didn’t show significant increase, with only a 10% increase in correct responses after the intervention. Graphical presentation of these data can be seen in **Figure 2**.

## **DISCUSSION**

In support of H1a, we found that the SMARxT intervention was feasible to implement, as evidenced by findings such as a 70% completion rate, a self-reported estimate that 89% of video material was watched, and qualitative comments supporting feasibility. In support of H1b, we found that the intervention was generally acceptable to the intended audience, as evidenced by post-test Likert-type assessments (e.g., **Figure 1**) and the major qualitative themes (e.g., **Table 2**). Finally, in support of H2, comparison of pre- and post-intervention data suggested significantly increased knowledge of topics covered in video modules related to pharmaceutical marketing and evidence-based prescribing.

**Figure 1**  
**Attitudes toward the SMARxT program**

*Participants were asked to rate their attitudes, from strongly disagree to strongly agree, about different components of the program, such as whether they gained knowledge from the study, were entertained, or would recommend the program to others. In all questions, the majority of students had positive attitudes towards the program.*



A 70% rate of completion is heartening, especially for a population that is notoriously difficult to engage and retain (Reid, Thomson, and McGlade 2016). However, because 30% drop-out is not optimal, it will be important to address this issue before widespread implementation. Lessons learned during this study may assist us making certain procedural changes that may improve retention. For example, in qualitative comments, some students noted the fact that they are used to watching class-related material at 1.5 or double speed; thus, allowing this may have improved our retention rate. However, this change might negatively affect optimal assimilation of information (Ritzhaupt, Pastore, and Davis 2015). This is especially true because many of the aims of this program involve improvement of critical thinking and analysis rather than simple memorization of factoids. Therefore, the benefits and drawbacks of this formatting change should be consciously addressed before instituting this change. For example, it may be valuable for future research to examine whether there are differences in knowledge acquisition among individuals allowed and not allowed to watch at increased rates.

Another way of increasing the retention rate in this population is simply to make completion compulsory. Because medical students are extremely busy and pressured to focus on only compulsory activities, it may not be realistic to expect more than 70% retention for a voluntary program. However, given the extreme constraints on medical educators and medical school curriculum planners, it will be important to be strategic about why a program like this should be included. This is especially true because material such as that represented in SMARxT is unlikely to be strongly represented on standardized tests such as the United States Medical Licensing Examination (USMLE). One way of potentially elevating the status of programs such as these would be to emphasize how it addresses certain emerging competencies outside of medical knowledge. For example, the Accreditation Council for Graduate Medical Education and the American Board of Medical Specialties specifically emphasize the importance of domains such as Interpersonal and Communications Skills and Systems-Based Practice (Englander et al. 2013). Because some medical schools are currently struggling with ways of addressing these competencies, use of programs like SMARxT may provide a synergistic and mutually beneficial solution.

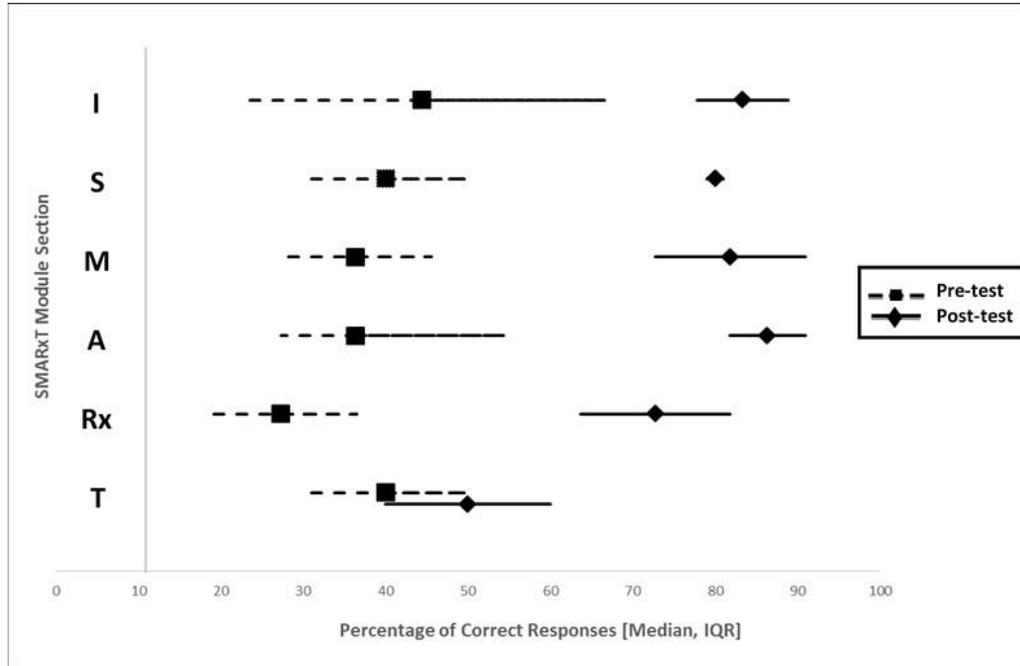
Acceptability was generally quite strong. While there were both positive and negative comments represented in the qualitative information, the quantitative results around acceptability indicated that there seemed to be only one individual of the 21 involved who had an overall negative assessment. Within the different domains of acceptability, **Figure 1** shows the strongest agreement was with items around learning new information, with 76% of participants scoring the program with a 9 or 10 out of 10 in this area.

While scores around entertainment were slightly lower, they were still generally very strong. Because the main purpose of the program is to impart information, and entertainment value is secondary in support of this primary objective, these results suggest that there is not substantial change that needs to be made in order to improve entertainment value.

**Figure 2**

**Median and IQR percent correct responses of pre- and post-test.**

*Forest plot displays the pre- (dashed-line, squares) and post-test (solid-line, diamonds) correct responses to show improvement of knowledge base before and after the intervention. Values are displayed as median and IQR percentages. Significant improvement is seen in all sections of the program, except the final module, Tools, which shows mild improvement but still overlaps with pre-test data.*



The finding most indicative of acceptability may have been the fact that greater than 80% of participants rated SMARxT with 8 or above out of 10 when asked if they would recommend this program to other trainees, which suggests that medical students recognize the overall value of this type of information in medical education. This point, along with the fact that students felt they gained new knowledge, suggests that there is a lack of education on these topics in current medical education. This was also supported by comments in open-ended questions, in which participants described the programming as “eye-opening” and “valuable.” One student went as far as to say that the program should be “mandatory for student doctors.”

In support of H2 around efficacy, results from pre- and post-testing showed a statistically significant increase in correctly answered questions, from an average of 24 to 47 correct responses out of the 62 total questions ( $P < 0.001$ ). It is interesting that pre-test knowledge was so low; 39% (24 out of 62) accuracy is not much higher than the 20% that would be expected simply due to chance (because there were 5 choices for each multiple-choice item). Because each multiple-choice correct response was supported by a specific fact in

published literature, these low initial scores were not simply because of differences in opinion. This low pre-test knowledge further emphasizes the potential importance of educating students around pharmaceutical marketing and evidence-based prescribing.

While the number of correct responses approximately doubled, suggesting a strong effect size, it still should be noted that post-test percentage correct was only 76%. One interpretation of this is that it would be useful to carefully reassess and hone the curriculum in order to ensure that all information is clearly provided. However, it should also be noted that this level of correct response is standard for rigorous medical licensing tests. For example, passing the initial USMLE examination only requires correctly answering approximately 60 to 70% of the items. Thus, while students commented on the “particular” and “difficult” nature of some of the questions, this rigor may actually be valuable in elevating the status of this material to other topics in the medical education curriculum.

Stratified analyses of knowledge changes, as shown in **Figure 2**, suggested that the sixth module (“Taking Advantage of Tools”), which focused on leveraging technology such as mobile applications to improve evidence-based care, was the least associated with knowledge change. One potential reason for this is related to the fact that technology changes so quickly. For example, if an item asks whether a given mobile application has a certain feature, the answer may have been “no” last month but “yes” today. Therefore, while it will be important to periodically reassess all items for accuracy, this will be especially important in this section. Another possibility is that this was the last section of the program, and this may have led to students being less attentive. Because this raises concerns about the length of the program, it may be valuable in future qualitative assessments to specifically address this. Another option would be to conduct future testing by varying the order of modules. While the program was developed for optimal use in the given order, it is not strictly necessary.

### **Limitations**

The sample for this study was largely composed of second-year medical students. This is probably to be expected, because first-year students are notoriously engrossed in passing initial coursework and third- and fourth-year students are less available because they are rotating through different community-based sites (which can involve travel). Thus, these results are not necessarily representative of all medical student years, and future work should endeavor to include more equal representation. Similarly, while these ideas are potentially relevant to many other health professionals such as physician assistants, nurse practitioners, and pharmacists, we did not include these individuals in the current analysis. Another necessary limitation of qualitative work such as this is that interpretation of findings can be subjective, though we endeavored to employ a structured and iterative analytic process to account for this.

**Table 2**  
**Qualitative feedback on the SMARxT program (n = 21), 2015–16**

<b>Themes</b>	<b>Example/Comments</b>
<b>POSITIVE FEEDBACK</b>	
<b>Educational</b>	<p>“I found the program to be very eye-opening. It provided good information and historical data to promote greater awareness of how pharmaceutical companies operate and influence the drug market.”</p> <p>“I learned more about drug practices and basically to be more aware of things.”</p> <p>“The discussion of medical smartphone apps was useful, especially for a new third year medical student that is still learning which apps to use.”</p> <p>“I think this should be mandatory for student doctors.”</p>
<b>Simple-to-use</b>	<p>“The videos were fairly short and easy to understand.”</p> <p>“Easy way to learn new stuff.”</p> <p>“The pre-test was helpful to know what the study authors thought were the most important take away points were to pay attention when watching the videos”</p>
<b>Entertaining</b>	<p>“Occasional jokes in the videos helped me pay attention.”</p> <p>“Extremely clever and entertaining!”</p>
<b>NEGATIVE FEEDBACK</b>	
<b>Video Speed</b>	<p>“Speed it up!! Your audience is use to podcasts at 1.5x or 2.0x speed.”</p> <p>“Have an options to play videos at 1.5x or 2x speed. I often felt as though the pacing was too slow.”</p> <p>“I think that the characters could have talked faster without compromising comprehension. In fact, I think that is they had talked a little faster, I would have been forced to actually pay more attention and might have been more engaged.”</p>
<b>Video Length</b>	<p>“Would recommend cutting out any such fluff/repetition, as surely residents are going to be even more pressed for time than a medstudent.”</p> <p>“Some of the videos were too long and hard to pay attention throughout the entire time.”</p> <p>“Examples were repeated in separate videos [...] maybe presenting this data in just one of the videos could shorten overall length of the videos and increase how attentive the audience is.”</p>
<b>Confusing Questions</b>	<p>“Some of the comprehension questions in the website/app section were very particular.”</p> <p>“Some of the ‘except’ questions were difficult to answer.”</p> <p>“the last two sessions were the hardest to answer questions correctly [...] I’m not sure the questions were useful in assessing how much I learned.”</p>

## CONCLUSIONS

Testing the SMARxT program with medical students showed that the program was generally feasible, well accepted, and effective in its purpose. However, testing also revealed important potential areas for improvement, including partnering with curriculum designers to explore ways of making programming such as this compulsory, considering allowing participants to view the program at increased speeds, and frequently fact-checking assessment items related to rapidly-changing technology. Continued research on the program with a wider variety of medical students and with medical residents will be valuable as program scope grows.

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