The Miniproject: An initial step in scientific research skill development for first-semester medical students

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Abstract

Although medical students involved in research training express greater interest in academic medicine, a paucity of clinician-scientists remains. Herein, we describe a feasible project, titled 'The Miniproject,' which introduces first-semester medical students to basic concepts in scientific research. The Miniproject was introduced in 2007 as part of a major curriculum reform to provide a structured, systematic approach to scientific training to Karolinska Institute's study programme in Medicine. The Miniproject itself was developed in recognition that emphasis is increasingly placed on student-centred study, which involves greater assumption of responsibility by the student for his or her own learning. Over the course of five days during the first weeks of medical school, students participate in a variety of activities designed to align with five intended learning outcomes. These intended learning outcomes include: formulating a scientific hypothesis; discussing, in broad terms, at least one method used to answer a scientific question; giving and receiving feedback from peers and teachers; demonstrating the ability to search, interpret, present and discuss written and oral scientific medical information; and actively engaging in a small group discussion. Teachers facilitate small group discussions, but encourage students to lead these discussions. Via electronic, anonymous evaluations, most students (65.1%) evaluated the Miniproject as good or very good. In conclusion, the Miniproject is a feasible project led by researchers, and which is designed to introduce first-semester medical students to scientific literature and the research process, as initial steps in the scientific development thread.

Keywords: Clinician-scientist, Medical education, Self-directed learning

Background

Medical doctors with research training contribute to the advancement of medical knowledge as a result of their unique ability to work both with patients and in a research environment. Medical students involved in research training express greater interest in academic medicine (Greenberg RC et al., 2013; McManus IC, Richards P, &
Winder BC, 1999). However, few medical students receive such training (Holsti M, Adelgais KM, Willis L, Clark EB, & Byington CL, 2013). This, and a perceived lack of opportunity, skills and time (Russell CD et al., 2012) has resulted in a paucity of clinician-scientists, a disconnect between clinical practice and research work, and limited translational research (Roberts SF, Fischhoff MA, Sakowski SA, & Feldman EL, 2012; Soloman SS, Tom SC, Pichert J, Wasserman D, & Powers AC, 2003). Strategies on engaging medical students in research in hopes that they become future clinician-scientists have been discussed extensively (Ballios BG & Rosenblum ND, 2014; Culican SM, Rupp JD, & Margolis TP, 2014; Soloman SS, et al., 2003). Medical students who invest themselves in research either early and/or substantially in their training are most likely to become clinician-scientists (Culican SM, et al., 2014). Karolinska Institutet (KI) is taking action to attract medical students to understand the scientific basis of medicine and interpret scientific findings in order to become scientifically skilled clinicians. We contend that introduction to research, as well as face-to-face discussions with medical researchers during the first weeks of training will stimulate medical students' interests in scientific research early in their training. Herein, we aim to describe the Miniproject, a feasible project designed to introduce first-semester medical students to some basic concepts in scientific research via exposure to scientific literature, to the research process and to researchers, as an initial step in the scientific development thread during medical school (Plymoth A, Möller R, & Protudjer JLP, 2014).

Activity- History of the Miniproject

The Miniproject was introduced in 2007 as part of a major curriculum reform to provide a structured, systematic approach to scientific training to KI'S study programme in Medicine. The Miniproject itself was developed in recognition that emphasis is increasingly placed on student-centred study, which involves greater assumption of responsibility by the student for his or her own learning (Rowntree D, 1990) and requires that teachers design and engage learning activities that stimulate deep learning and that permit students to achieve the intended learning outcomes (ILO) (Biggs JB & Tang CS, 2011). The Miniproject was designed using an approach inspired by problem-based learning, as problem-based learning empowers students by enhancing their communication skills and getting them more involved in the learning process, as compared to traditional teaching methods (Norman G, 2008). Teachers are seen as learning facilitators (Harden RM & Crosby J, 2000), not disseminators of knowledge. As such, the Miniproject assumes a constructivist approach to learning, such that students' knowledge is 'constructed' and continually developing (Brooks JG & Brooks MG, 1993).

Activity- Intended learning outcomes

The ILO of the Miniproject are (a) to formulate a scientific hypothesis; (b) to be able to discuss, in broad terms, at least one method used to answer a scientific question; (c) to give and receive feedback from peers and teachers; (d) to demonstrate the ability to search, interpret, present and discuss written and oral scientific medical information; and (e) to actively engage in a small group discussion.

Activity- Learning activities

The teaching and learning activities and assessment are systematically aligned with ILO in order to achieve constructive alignment (Biggs JB & Tang CS, 2011). Students are required to actively engage in these learning activities in order to successfully complete the Miniproject (Plymoth A, et al., 2014).
The Miniproject is designed to be completed in 40 hours (five days) of class time, lecture time and preparation time.

Days 1 and 2 involve lectures on formulating scientific hypotheses, study design, biostatistics and scientific communication (Protudjer JL & Plymoth A, 2016)

In advance of Day 3, students receive a triad of Medical Subject Headings (MeSH) terms assigned by a teacher, which the students are required to define using the MeSH database. A single triad contains related terms, and triads assigned to different students in the same seminar (described below) by the same teacher may be related. Teachers include both clinical and pre-clinical MeSH terms to emphasise the broad and integrated nature of clinical medicine and of the study programme in Medicine, as reflected in ILO and activities. At this time, students also download a short introduction of their teacher’s research area from the e-portfolio in the electronic learning management system. This short introduction helps increase students’ familiarity with the teachers’ research areas.

On Day 3, the students are introduced to the university library facilities and resources. They also receive tutorials on PubMed and the MeSH database.

On Days 3 and 4, students search and read scientific abstracts relating to their MeSH terms and develop a hypothesis based on these abstracts. Subsequently, the students prepare individual five-minute presentations that include defining their assigned MeSH terms, presenting their hypotheses and findings from the abstracts that support or do not support the hypothesis. Given the short time allocated to the Miniproject, the course leaders decided to require that students read only abstracts, rather than full length publications. However, students are encouraged to read additional background literature to enhance their knowledge of the subject and to be able to adequately address questions. In addition, students must also write a 300 word summary, using the Introduction-Methods-Results-and-Discussion (IMRaD) structure, of their presentation.

On Day 4, students upload their short summary and presentation to their e-portfolio in the electronic learning management system. At the same time, students are required to download the written summaries of their fellow students.

On Day 5, each student presents his/her Miniproject hypothesis based on the MeSH terms to a group of 8-9 students and the teacher as part of the mandatory seminar. Fellow students have the opportunity to ask about ideas or concepts that were unclear during the presentation. Presenting students are encouraged to respond to the best of their abilities, but are not expected to be able to answer all questions. Subsequent to all presentations, the teacher facilitates the development of a concept map (Novak J, 1995) (see Figure 1 for an example). This technique was chosen for three reasons. First, it allows for the illustrative and descriptive presentation of relationship between MeSH terms, and stimulates scientific discussion. Second, it may demonstrate basic scientific explanations to clinical phenomenon, which may be a challenge in medical education. And, third, it also serves as an impetus for students to begin considering possible research areas for their semester-long degree project in Medicine, which takes place during semester 8 of KI’s 11-semester Study Programme in Medicine.

Table 1. Examples of assigned Medical Subject Headings terms (MeSH terms)

| Student | MeSH term 1 | MeSH term 2 | MeSH term 3 |
|---------|-------------|-------------|-------------|
| 1       | Epinephrine | Peanut hypersensitivity | Immunoglobulin E |
Activity- Assessment

The Miniproject involves two forms of assessment. First, immediately following each student’s presentation, the presentation and written summary are peer-reviewed by fellow students and teachers, using predefined assessment criteria. Such interactive, constructive and systematic feedback enhances opportunities to improve critiquing and communication abilities (Bienstock JL et al., 2007). Immediately after their presentations, students are informed if they had successfully completed the Miniproject. If they have not successfully completed the Miniproject, students are required to make any and all necessary changes prior to successful completion. In rare cases (<1% of cases, based on our experiences), students are required to redo their Miniproject at a make-up class.

Second, following the completion of the Miniproject, students and teachers anonymously evaluate the Miniproject using an electronic questionnaire. Results from systematic data collection beginning in the autumn semester of 2013 indicate that most (204/313; 65.1%) students who responded to the evaluation assessed the Miniproject as good or very good (Figure 2). Additionally, students described the Miniproject as ‘an inspiration for other angles of my work,’ and [an opportunity] to see things from another perspective’ or ‘to discover things I would not have seen with my own eyes.’ Collectively, these results reinforce that the Miniproject is a well-designed feasible activity to achieve its objective of introducing first-semester medical students to scientific research and is favourably reviewed by students.

Figure 1. Example of concept map resulting from students’ assigned Medical Subject Headings terms (MeSH terms)
Figure 2. Students’ overall assessment of the Miniproject

Discussion

The Miniproject has resulted in early introduction in scientific information competence and critical appraisal; early introduction in scientific communication; knowledge on formulating scientific questions and hypotheses; development and implementation of a community of practice including teachers from different disciplines and institutions; structured instructions for oral and written feedback; assessment by e-portfolio, and; continuous on-time course evaluations.

The strengths of the Miniproject include introducing medical students to research early in their training, which may serve to interest the students in research during and subsequent to their medical training. Further, the Miniproject can be feasibly implemented in medical school training, as the Miniproject demands a total of approximately 40 hours of study.

We acknowledge the limitations of the Miniproject. Students are only required to read abstracts, rather than full length publications. This decision was based on the time constraints of the Miniproject. However, both the time constraints and required abstract reading may also prevent deep learning. In a course such as the Miniproject, there is very little opportunity or perhaps even emphasis on deep learning. Unless students are highly motivated, they are unlikely to be stimulated to learn more (Biggs JB & Tang CS, 2011). Yet, we believe that most students are likely to be motivated, either intrinsically, or extrinsically, because they recognise that they will need to engage in a peer-to-peer discussion about their Miniproject presentations.

As students become more aware of research and its relevance to medicine they may also start involving research in their career plans (Greenberg RC, et al., 2013). In order to raise students’ understanding of the scientific basis of
medicine as well as the clinical practice, it is essential to start scientific development at an early stage in their training (Culican SM, et al., 2014). Previous methods to engage medical students in research vary greatly in terms of the time commitments required by students and faculty (Soloman SS, et al., 2003) (Bosse D, Milger K, & Morty RE, 2011; Hayward CP et al., 2011; Muslin AJ, Kornfeld S, & Polonsky KS, 2009). For example, one American medical school have 10-12 week programs that run during the summer between Years 1 and 2 (Soloman SS, et al., 2003), whereas another has a fast-track program that limits training in general medicine to two years, but requires clinician-scientist students to also complete two to three years of advanced research training (Muslin AJ, et al., 2009). Such programs are costly to plan, administer and deliver (Culican SM, et al., 2014), and/or are not designed to expose all students to research. Yet, research programs are critical to attracting medical students to a clinician-scientist position (Culican SM, et al., 2014). In contrast to the above-cited previous programs, the Miniproject requires a commitment of only one week, with only a very short time commitment from each faculty member. Thus, we believe that the Miniproject may be an appropriate, time-efficient and cost-effective way in which to introduce medical students to research, which may in turn, encourage them to pursue additional training and a career as a clinician-scientist.

In conclusion, the Miniproject is a feasible project led by researchers, and which is designed to introduce first-semester medical students to scientific literature and the research process, as initial steps in the scientific development thread.

Abbreviations

| Abbreviation | Description             |
|--------------|-------------------------|
| ILO          | Intended learning outcomes |
| KI           | Karolinska Institutet    |
| MeSH         | Medical Subject Headings |

Take Home Messages

Notes On Contributors

JLPP and AP drafted the manuscript together following their experiences as course leaders and teachers of the Miniproject.

RM is the program director of Karolinska Institutet’s medical program. She provided critical input into the manuscript and approved the final version prior to submission.

MJN participated in the development and implementation of the Miniproject in its early phases. He provided critical input into the manuscript and approved the final version prior to submission.

PD founded the Miniproject. He provided critical input into the manuscript and approved the final version prior to submission.
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Appendices
Declarations

The author has declared that there are no conflicts of interest.

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