

Supported self-directed learning of Clinical Anatomy: a pilot study of doughnut rounds

Yimeng Zhang¹, Marie A. Zerafa Simler^{1*}, Isabel Stabile²

¹Medical Student, University of Malta Medical School, ²Professor, Department of Anatomy, University of Malta

SUMMARY

Doughnut Rounds (DRs) are an innovative approach to self-directed learning (SDL). The purpose of this study was to explore the usefulness of DRs in learning the clinical anatomy of the lower limb. Seventeen Year 1 medical students attended six weekly hour-long sessions in small groups. Each student prepared five questions on a different clinical anatomy topic every week. During each session, students took turns to ask their questions to others in the group. Each incorrect/correct answer was then explained to the students. Each student took an identical MCQ test before and after each session to assess changes in their knowledge of the relevant clinical anatomy. The average pre/post MCQ scores increased by 39% ($p < 0.01$). Overall there was no statistically significant difference in the summative lower limb final examination results between DR participants and non-participants, perhaps because the effect, if any, of the DRs on learning was diluted by good exam preparation of the whole cohort. However, participation in the DRs reflected insignificant improvement in both written and practical final examination results in those students who were previously behind academically in their final end-of-semester exam results, when compared with non-participants in the same cohort. The majority of students either agreed or strongly agreed that the sessions improved their anatomical knowledge (87%) and confidence (77%). The great majority also agreed that the sessions were enjoyable, that formulating questions aided in their retention of

knowledge, and that the sessions were valuable in relation to the time and effort in preparing for them.

Formulating, asking and answering questions during Doughnut Rounds improve students' anatomical knowledge in an effective and enjoyable manner. We believe that this type of SDL can be applied to any number of topics across various medical disciplines.

Key words: Clinical Anatomy – Medical Education – Collaborative/Peer-to-peer teaching – Small group teaching – Self-directed learning – Near peer-assisted learning

INTRODUCTION

Self-directed learning (SDL) is an important skill for medical practitioners to acquire (Harvey et al., 2003). In SDL, learners take the initiative in making use of resources, with or without the help of others (Stanley et al., 1993). This approach has been shown to have benefits compared with didactic teaching such as lectures, tutorials, etc. (Peplow, 1990; Brookes, 1991; Dixon 1993). Doughnut Rounds (DRs) are but one type of SDL being gradually introduced into medical curricula.

Fleischer et al. (1997) chose to explore this method of teaching during a Surgical Intensive Care Unit rotation, utilising a game-show format. The 25 students were free to choose the material as a group and were asked to formulate twelve questions for each weekly session, for a total of three months. The authors concluded that the DRs benefited students because they were stimulated to read, think, and actively participate in their learning process.

Bulstrode et al. (2003) conducted a randomised

Corresponding author: Marie Adrienne Zerafa Simler. University of Malta Medical School, 89 Merchant's Street, VLT1177

Valletta, Malta.

E-mail: Adriennezerafasimler@gmail.com

Submitted: 22 February, 2017. *Accepted:* 27 June, 2017.

controlled study of DRs to examine their efficacy in teaching trauma and orthopaedics to Year 1 medical students. A total of 106 students were given relevant reading material a week in advance which was then further discussed during the sessions. At the end of the four sessions each student sat for an MCQ test, which was then re-administered 10 weeks and 17 months later. The authors concluded that DRs are as good as lectures in imparting factual knowledge in both the short- and long-term compared with lectures alone.

Jensen et al. (2016) applied Fleiszer's concept of DRs to a 'Dream Team' of pre-graduate students in an attempt to develop surgical talent. DR sessions were held every three weeks in groups of 8 focusing on laparoscopy surgical exercises and surgery on pigs in the fields of Urology, Gynaecology and General Surgery. In this study, the DRs were not evaluated independently of the whole intervention.

DRs have also been used as informal discussion sessions for curricular development in other disciplines, such as Nursing. Bowman et al. (1985) utilised DRs to identify the perceived needs of learners and hence identify new topics for continuing education. Although the results of the DRs were not objectively assessed in this study, they successfully allowed for the validation of previously existing hypothesis and the generation of others.

These studies have focused on DRs in the clinical disciplines of Surgery, Orthopaedics and Nursing. The purpose of this paper is to extend this study to the clinical anatomy of the lower limb in pre-clinical students.

MATERIALS AND METHODS

After ethical approval and informed consent, Year 1 medical students were recruited during the second semester of their studies following an invitation to participate via E-mail. Students were divided into three groups of 6-8. This allowed time for each student to ask a minimum of five questions during DRs. Students had completed the anatomy of the upper limb in semester 1.

The anatomy of the lower limb was divided into six topics as follows: Hip and Gluteal Region; Anterior Thigh, Knee, and Popliteal Fossa; Foot, Foot Arches, and Sole; Lumbosacral Plexus, Dermatomes and Myotomes; Vascular Supply; and Back, Gait and Physiotherapy.

The DR sessions consisted of six weekly hour-long sessions chaired by Year 4 medical students (Peer-Assisted Learning), where one of the topics was discussed each week. The role of the Year 4 medical students was to ensure the quality of the questions asked and to clarify any misconceptions. Students were told which topic would be discussed a week prior to the session and were expected to revise the subject matter and prepare five straightforward questions related to the topic. During each

session, students took turns to ask their questions to others in the group in a game show format. Each correct and incorrect answer was discussed among students, with the Year 4 students ensuring that the questions were fair and that the answers given were correct. Care was taken to ensure that each session was scheduled after students had completed the relevant timetabled lectures and small group teaching organised by the faculty. Each student took an identical Multiple Choice Question (MCQ) test (including 17 True/False/Don't Know and 9 Best of five questions) before and after each DR session to assess change in their knowledge of the relevant clinical anatomy. The True/False/Don't Know questions were negatively marked to discourage guessing.

The students completed a questionnaire before and after each session to explore their expectations and perceptions. They also completed a questionnaire at the end of the six sessions to assess their overall feedback. The questions were ranked on a scale of 1 to 5 from strongly agree to strongly disagree.

At the end of the academic year, approximately 4 weeks after the DR sessions had been completed, all Year 1 students were invited to attend a mock exam composed of negatively marked True/False MCQs, covering both lower limb and upper limb topics. During analysis, the results of the upper limb questions in the mock exam served as a control for those of the lower limb, as the upper limb was covered during the first semester before the DRs were conducted.

All Year 1 students undertook the end-of-semester lower limb anatomy examination approximately 6 weeks after the end of the DR sessions. They had taken a similar exam in the previous semester on corresponding topics in the upper limb (without DR sessions). The results of the two exams were anonymised and Paired t-tests were used to analyse differences between DR and non-DR participants.

RESULTS

A total of 17 Year 1 medical students were recruited for the study, including 10 local students (58%), one European (6%) and six non-European international students (36%). The average attendance for all six sessions was 67%. Table 1 shows the attendance at each session.

Session Results

The average pre/post session MCQ scores for all DR were 30% and 42% respectively, representing a 39% pre/post-test increase. All but one student improved their average post-session mark. Overall, students scored better in the Best of Five compared with True/False MCQs. For the purpose of this analysis, results were combined. There was no significant gender difference between participants and non-participants in both the mock exam

Table 1. Number of students attending each session.

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
Number of students	10	11	10	12	11	14

Table 2. *p*-Values for change in MCQ scores per session.

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
<i>p</i> -value	0.0130	0.0325	0.0806	0.0052	0.0090	0.0077

Table 3. Results for pre and post-session subjective questionnaire.

		Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Pre-test	Prior to preparing for this session, I had good anatomical knowledge of this topic	3.0	21.2	39.4	30.3	6.1
	I expect that this session will enhance my knowledge of this topic	27.3	57.6	15.2	0.0	0.0
	I feel this session will be clinically significant	25.0	62.5	12.5	0.0	0.0
	I expect this session will enhance my confidence and communication skills	6.1	63.6	30.3	0.0	0.0
Post-test	I gained appropriate anatomical knowledge while preparing for this session	13.3	50.0	23.3	13.3	0.0
	I gained appropriate anatomical knowledge while attending this session	40.0	46.7	6.7	3.3	3.3
	This session has enhanced my confidence and communication skills	33.3	43.3	23.3	0.0	0.0
	I feel that donut round sessions are a more enjoyable way of learning anatomy compared to standard lectures/small group teaching sessions	36.7	46.7	10.0	6.7	0.0
	I found this session valuable	53.3	30.0	16.7	0.0	0.0

and the final end-of-semester examination.

Paired *t*-tests were used in order to calculate significant change between pre- and post-test MCQ scores for each session (Table 2). Overall, there was a statistically significant improvement in the post-test compared with the pre-test results ($p < 0.01$).

A total of 33 responses (49% response rate) to the subjective questionnaire were collected prior to attending each DR session. The post-session response rate was 44% ($n=30$). Results are shown in Table 3.

On average, students spent around 15-30 minutes preparing for each session, with a minority of the students spending under 15 minutes or more than 60 minutes.

The results of the final subjective questionnaire are found in Table 4.

Mock Exam Results

A total of 44 Year 1 medical students participated in the mock test approximately 4 weeks after completion of the DRs. These included all 17 participants and 27 other non-participants. There was no significant difference in the MCQ scores in the mock test between participants and non-participants.

End of Semester Exams

A total of 131 students completed the end of semester exams, 17 of whom were DR participants. Of the 114 students in the control group, 96 (84%) were local, 12 were European and 8 were non-European international students. Exam results are shown in Table 5. Participants had obtained 5% lower marks than non-participants on average in the upper limb written exam (59% and 64% respectively), prior to taking part in the DR sessions. Although not statistically significant, after the DR sessions participants had only 1% lower marks in the lower limb exam, when compared with non-participants (74% and 73% respectively).

However, there was a significant difference between EU and non-EU participants' total marks (7.6%, $p=0.01$) in both upper limb and lower limb exam results. Non-EU participants also showed a statistically significant improvement compared to non-participants in the lower limb written examination and practical (13.2%, $p=0.04$ and 15.8%, $p=0.02$, respectively).

EU participants improved significantly in the lower limb practical examination compared to non-participants ($p=0.04$). This difference of 27.2% was not found in any of the other examinations taken

Table 4. Final subjective questionnaire result.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Knowing that questions would be asked by your peers helped you to prepare well before attending the sessions.	41.2%	29.4%	29.4%	0.0%	0.0%
The sessions were valuable relative to the time and effort in preparing for them.	35.3%	58.8%	5.9%	0.0%	0.0%
The discussions arising around the answers added to your understanding of the topic.	58.8%	41.2%	0.0%	0.0%	0.0%
Having to formulate questions (rather than just reading the material) led you to a better retention of the material.	64.7%	35.3%	0.0%	0.0%	0.0%
It is important for the 4th year student not to dominate the session.	47.1%	11.8%	35.3%	5.9%	0.0%
Doughnut Rounds are at least as effective as other methods of teaching.	23.5%	47.1%	17.6%	11.8%	0.0%
The Doughnut Rounds fulfilled your expectations.	41.2%	35.3%	23.5%	0.0%	0.0%
The Doughnut Rounds were fun.	58.8%	35.3%	5.9%	0.0%	0.0%
You would attend other sessions of Doughnut Rounds if these were offered for other modules.	47.1%	41.2%	5.9%	5.9%	0.0%

Table 5. End of semester examination results.

	UL Practical				UL Written				UL Overall Score*			
	Local	EU	Non-EU	Total	Local	EU	Non-EU	Total	Local	EU	Non-EU	Total
Participants (n=17)	71.90	50.00	58.67	68.24 ($\sigma^2 = 229$)	60.90	48.00	55.23	59.35 ($\sigma^2 = 123$)	64.17	48.60	66.67	62.02 ($\sigma^2 = 111$)
Non-Participants (n=114)	67.26	61.20	59.13	66.19 ($\sigma^2 = 196$)	65.89	59.50	50.50	64.25 ($\sigma^2 = 174$)	66.31	60.01	53.09	64.83 ($\sigma^2 = 150$)

	LL Practical				LL Written				LL Overall Score*				Number of Students Failed
	Local	EU	Non-EU	Total	Local	EU	Non-EU	Total	Local	EU	Non-EU	Total	
Participants (n=17)	80.00	53.00	88.33	81.35 ($\sigma^2 = 242$)	71.00	62.00	76.83	72.53 ($\sigma^2 = 97$)	73.70	59.30	80.28	75.18 ($\sigma^2 = 113$)	0
Non-Participants (n=114)	80.63	80.20	71.14	80.02 ($\sigma^2 = 192$)	74.90	70.90	67.50	73.66 ($\sigma^2 = 88$)	76.61	73.69	65.93	75.61 ($\sigma^2 = 102$)	4

*NB The final score is based on the sum of the written (85%) and practical (15%) scores

by the same students.

None of the DR participants failed the written component of the lower limb end-of-semester-exam, compared with 4 non-participants (3.5%).

DISCUSSION

This is the first study of the application of the concept of DRs in pre-clinical medical students, and specifically to the clinical anatomy of the lower limb. Consistent with the findings of Fleischer et al. (1997), the majority of students either agreed or strongly agreed that the sessions improved their anatomical knowledge (86%), as well as communi-

cation skills and confidence (77%). Moreover, over 80% of students agreed that the sessions were enjoyable and valuable compared to standard lectures/small group teaching sessions.

In light of the fact that all students were offered the same set of lectures and other small group teaching on the lower limb prior to attending the DRs, the average pre-test score of 30% is somewhat disappointing. This might be explained by lack of student preparation for the sessions, the construction of the tests themselves or perhaps because the True/False questions were negatively marked to discourage guessing.

There was a statistically significant improvement

in the overall post-test compared with the pre-test MCQ score, suggesting that the reciprocal question/answer Doughnut Round sessions helped students learn new material. These findings are consistent with those of Bulstrode et al. (2003), and support the recommendation that this type of SDL may be usefully extended to clinical anatomy.

Two-thirds of the students agreed or strongly agreed that their anatomical knowledge improved while preparing for the sessions, while 86% reported that this improvement in knowledge occurred during the session itself. However, since the majority of students reported spending less than 60 minutes in preparation time, it is possible that the significant improvement in post-session MCQ scores was due to lack of preparation for the sessions rather than gain in knowledge of the topic during the DRs themselves.

Overall, there was no statistically significant difference in the summative lower limb final examination results between DR participants and non-participants. Although this is disappointing, given the significant pre/post-test improvement in MCQ scores, it is well known that in general students prepare themselves very well for examinations, so it is quite possible that the effect, if any, of the DRs on learning was diluted by good exam preparation of the whole cohort.

Nevertheless, non-EU DR participants scored statistically significantly higher in the final summative lower limb written and practical examination than non-DR participants, while EU participants scored higher in the practical examination than non-participating students. This suggests that participation in the DR sessions may have benefited those who took part, especially among non-EU students who typically obtain lower scores than their peers. We postulate that the latter may have benefited most from the DR sessions, because they may be less familiar with questioning and self-testing as an effective learning tool.

The DR sessions not only allowed students the opportunity to be tested on certain topics, they also encouraged discussion and debate, making students think more deeply about the reasons behind certain answers and how they can best remember them for future examinations. The one student who showed a decrease in MCQ scores attended only four of the six sessions, with a decrease of only one mark. However, due to his low total mark, this represented a large percentage decrease (21%), which may have negatively skewed our results.

Highlighting the importance of Near Peer-Assisted Learning (N-PAL), most students did not feel that they had sufficiently good clinical anatomical knowledge prior to preparing for the sessions, in spite of already having attended the relevant department-lead lectures/tutorials/dissection teaching. Students had high expectations of the

efficacy and clinical relevance of the DR sessions, expecting them to improve their confidence along with communication skills. Their high expectations were matched by what they reportedly gained, as reflected in the post-session questionnaire data.

There was no significant difference in the MCQ scores of the mock test administered one month after the end of the DR sessions between DR participants and non-participants, which may indicate lack of retention of knowledge. It is noteworthy that as a group DR participants had obtained on average 5% lower marks than non-participants in the upper limb final examinations the previous semester. Perhaps this is why they signed up for the DR sessions in the first place. The upper limb and lower limb exams were identical in terms of question styles and knowledge expectations. The difference in marks between participants and non-participants decreased to only 1% in the lower limb exams, suggesting that the DR sessions may have helped them improve their knowledge, retention and understanding overall.

Despite our best efforts to recruit students, only 17 agreed to participate in the study. This significantly affects the power and reliability of the results. As the students were informed that they could drop out of the study at any point, many students did not attend every DR session. Nevertheless, the data are consistent with those of Fleiszer et al. (1997), with the majority of students reporting that the sessions were effective, relevant and enjoyable.

Some students reported that the sessions would have been of even greater benefit had they been more actively directed by the Year 4 students, probably because different students have different abilities to be self-directed in their learning. It is also possible that some students actually prefer a more passive learning approach. Indeed, the majority of participating students had never experienced SDL before, having been conditioned by lecturers' instructions as to what they are to learn. It is not unusual for such students to become anxious when confronted with the responsibility of thinking through what they need to learn and how to go about learning it.

Although the Year 4 students did not actively participate in the sessions, they made sure that all the questions were relevant and appropriate. Certainly, they did not need to intervene more than one or twice per session, as the Year 1 students were on the right track most of the time.

In this study, students were not given the option to choose which topics would be covered during sessions themselves. This was reported to be of importance by Fleiszer et al. (1997), whose study was conducted in a clinical setting, allowing for greater flexibility in the choice of topics that students felt were relevant to their practice. There is evidence that self-direction can be learned especially when the students' underlying motivation for

SDL is recognised (Regan, 2003). We chose to guide students to focus on anatomy topics known to be important for their final examinations, as there is compelling evidence of the importance of assessment in student motivation to learn (Regan, 2003).

DR participants had high expectations and were very satisfied with the sessions. They all agreed or strongly agreed that formulating questions themselves aided in their retention of knowledge, and over 90% reported that the sessions were valuable in relation to the time and effort in preparing for them. Knowing that questions would be asked by their peers appeared to be a strong motivator, and reportedly the discussion around the questions aided learning. This is consistent with the significant increase in MCQ scores after each session, and possibly also participants' better ability to more accurately estimate their marks compared to non-participants. This is a valuable skill for students to have developed, in and of itself.

By the end of the sessions all but two students felt that the DRs were at least as effective as other methods of teaching and more than three quarters agreed or strongly agreed that DRs should be a regular part of the medical curriculum. This suggests that serious consideration should be given to more widespread implementation of this learning approach.

A supported SDL approach has been shown to improve student engagement, leading to deeper learning and better understanding and knowledge of anatomy (Findlater et al., 2012). This study confirms that N-PAL can effectively deal with misunderstandings and guide Year 1 students in more complex clinical anatomy topics as needed. N-PAL is often used as an adjunct in the dissection room especially within courses that have large numbers of students (Durán et al., 2012). This pilot study shows that N-PAL utilising DRs is feasible, valuable and enjoyable.

In conclusion, DR sessions proved not only to be an effective method of learning clinical anatomy, they also reportedly improved the confidence and communication skills of participating medical students. Participation in the DRs was reflected in improvements in those students who were previously behind academically in their final end-of-semester exam results, when compared with non-participants in the same cohort. Students also found the sessions to be more enjoyable when compared to standard lectures and small group teaching. We believe that this type of SDL could be applied to any number of topics across various medical disciplines.

ACKNOWLEDGEMENTS AND CONFLICTS OF INTEREST

We gratefully acknowledge the help of Sophie Noelle Hackenbruch, Saud Majid Aldhuhli and Ma-

zoon Al Jabri, in recruiting students for this project.

There are no conflicts of interest to declare.

This study was approved by the University Research Ethics Committee (UREC) – University of Malta.

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