5

New students – old sins: elephant in the (lab)room

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Abstract

Laboratory exercises are important in science education as they contribute to general understanding of the topics presented in lectures and enable students to acquire hands-on experience of the scientific research. However, conscious participation in the practical courses allowing for complete achievement of their learning outcomes depends on the proper pre-laboratory preparation. Unfortunately, it is a common problem that students show up under-prepared to participate in the laboratory sessions. This study focuses on medical students, and analyses the level of their pre-laboratory preparation, used techniques, resources and motivational force of the activities. The results show that students do not spend enough time for the preparation and do not use online-based materials. The main reason for under-preparation turns out to be the lack of time. This project discusses also implementation of the possible motivational activities that could enhance the student preparedness and overall performance in the laboratory.

Introduction

Laboratory exercises create learning environment encouraging students to ask questions and helping them to develop critical thinking. There are many specific learning outcomes of practical lab courses such as conceptual understanding of subject, and development of scientific reasoning and laboratory manipulative skills (Hofstein & Lunetta, 2004; Tobin, 1990; Hof-

stein, Navon, Kipnis, & Mamlok-Naaman, 2005). In addition, laboratory courses carry other important objectives including hypothesis formulation, development of observational skills as well as reporting, presenting and discussing the data collected during practical exercise (Reid & Shah, 2007). Thus, this form of practical teaching complements lectures on a given subject and bridges the theory with applied science research. However, the key prerequisite to a successful achievement of goals and learning outcomes of the laboratory-learning environment is the proper level of preparation expected from the students (Gregory & Di Trapani, 2012). While both the length/workload and the level of the practical courses can vary to a large extend, it is always expected that students will spend time preparing for the exercise. Unfortunately, typically students do not invest enough energy and time into the pre-laboratory preparation that prevents them from full participation in the exercise. As a result, they cannot grasp the aims, follow experimental procedures and comprehend the coherency behind the work design (Gregory & Di Trapani, 2012; Rollnick, Zwane, Staskun, Lotz, & Green, 2001; Pogacnik & Cigic, 2006). This has an obvious detrimental effect on conceptual knowledge development because the cognitive resources are occupied with irrelevant activities, thereby obstructing the learning processes.

The lack of preparation is a commonly observed and described phenomenon seen in many generations of the students, still being an elephant in the room problem; partially avoided, as it is difficult to tackle. Hence, the present project investigates the approach of the students towards preparation for laboratory courses, and presents the analysis and discussion of the data obtained directly from medical bachelors.

Purpose of the study and methodology

The main purpose of this study is to investigate the level of pre-laboratory preparation, used techniques, resources and driving force behind the activities. Moreover, it also seeks to identify potential links between preparation efforts and experimental learning outcomes with the special focus on the implementation of online/virtual resources. The data presented in the study were obtained from a questionnaire consisting of both closed and open-ended questions (Appendix A). The questionnaire was answered anonymously by 30 medical bachelor students (semester 5) participating in the practical exercise conducted during “Kidney and the Urinary Tract” course,

held at the Faculty of Health and Medical Sciences in September 2017. The questionnaire was divided into two main sections; the first five questions were retrospective and connected to the previous courses that students held during first four semesters, the last three questions were specifically connected to the preparation for the "Kidney and the Urinary Tract" laboratory course.

Results

First, I was interested in investigating how much time on average students used to spend preparing for laboratory classes held in the first four semesters of their medical study program (Appendix A,Question 1). Figure 5.1 shows the typical amount of time used for preparation for the practical courses using both hard-copy- and online-based materials (Fig.5.1a and b, respectively). It can be seen that 50 % of students spent only 0-30 minutes for pre-laboratory preparation using hard-copy based materials (e.g., laboratory manuals or textbooks; Fig.5.1a). This may imply that some fraction of these respondents shows up for the practical courses completely unprepared. The smallest group of respondents (i.e., only 10 %) were the students who prepared for more than 1 hour (time duration 60-120 minutes), suggesting that long pre-laboratory preparations are not popular among medical students. Strikingly, 100 % of respondents fell in the group that reported to use 0-30 minutes for preparation employing materials available online (Fig.5.1b). Consequently, this could indicate that, due to various reasons, a lot of students do not use virtual-based materials at all. Overall, 10 % of students disagreed strongly that they were always prepared for the laboratory exercises and only 16.7 % considered themselves as being always prepared (Fig.5.2; Appendix A,Question 3).

Subsequently, I investigated the preferred form of preparation for the practical courses (Appendix A,Question 2). All 30 respondents answered that they usually prepare alone (i.e., self-study preparation), indicating that both study-group or other preparation forms are not popular among medical students. When asked for the driving force behind pre-laboratory preparation (Appendix A,Question 4), the vast majority of the students (i.e., 71.4 %) pointed towards willingness to benefit from the laboratory exercises to a maximum possible extend (Fig.5.3). The objective of obtaining the best hands-on experience was the least motivational and reported by mere 8.6 % of medical students. One student was motivated by "other reason" be-

ing “to understand what was to happen”. In addition, also the main factor for not preparing was investigated (Appendix A,Question 5). Here, the biggest fraction of respondents (i.e., 70.6 %) attributed the lack of preparation to the lack of time, with lack of motivation or interest being evenly distributed (i.e., 8.8 %; Fig.5.4). As the “other reasons” students gave, e.g., “too difficult laboratory manuals with bad overview of the exercise”, “lack of purpose, often they explain it all in the laboratory” or “lack of previous lectures”.

As mentioned earlier, the three last questions asked concerned exclusively the preparation for the practical part of the “Kidney and the Urinary Tract” course. Here, in line with the previous findings, an average time spent on preparation was analysed (Appendix A,Question 6). The distribution of time duration spent on preparation for this particular laboratory course using hard-copy-based material was very similar as for the courses students held in the first four semesters, with 53.3 % of respondents preparing for 0-30 minutes and only 10 % for 120-240 minutes, respectively (Fig.5.5a). Also, distribution of preparation time based on online material followed the previously observed trend with only 3 out of 30 students (i.e., 10 %) spending 30-60 minutes employing this kind of aids and remaining 90 % of respondents reporting to use 0-30 minutes on a virtual-based preparation approach (Fig.5.5b). The last two questions concerned the helpfulness of both accompanying course lectures and provided laboratory manual in pre-laboratory preparation (Appendix A,Questions 7 and 8, respectively). In general students agreed that the lectures complement well the practical exercise (31 % wholly agreed, 62 % partially agreed; Fig.5.6) and that the laboratory manual is sufficient for the preparation (73.3 % wholly agreed; Fig.5.7).

Discussion

The results presented in this project confirm clearly that the target group, i.e., medical bachelor students enrolled at the Faculty of Health and Medical Sciences, does not spend enough time for pre-laboratory preparation. This is a common phenomenon, observed also in other study programmes, e.g., biological or chemical (Gregory & Di Trapani, 2012; Rollnick et al., 2001; Pogacnik & Cigic, 2006; Reid & Shah, 2007). Moreover, students base the preparation almost exclusively on hard-copy-based materials. From the collected data, it can be assumed that the usage of online-

based material is extremely limited. The reasons can be that such tailor-made resources are not being commonly developed and implemented to the teaching at University of Copenhagen, and also that students are not interested, too busy or simply not encouraged to look for the online content themselves. There are a lot of free online sources (e.g., youtube.com) offering videos related to biological, chemical or medical laboratory experiments. Hopefully in the future virtual materials will be much more commonly employed at University of Copenhagen, as this kind of educational aid was shown to be both attractive and helpful in conducting of laboratory exercises (Makransky, Thisgaard, & Gadegaard, 2016; De Jong, Linn, & Zacharia, 2013; Waldrop, 2013). Moreover, such an addition to a hard-copy-based preparation approach may actually ease understanding of the laboratory manuals that are often too complicated or base too much on the previous knowledge causing cognitive overload.

The lack of the pre-laboratory preparation can be associated with the lack of pre-laboratory knowledge execution and lack of consequences for taking the classes unprepared. In the Danish educational system, all students are accepted for the practical exercises (that often are compulsory) without fulfilling any prerequisites. There is no requirement of entry written test, synopsis or oral colloquium/discussion qualifying and allowing the students to enter the lab courses. These forms are successfully used in other countries and are clearly elevating the level of pre-laboratory preparation (Rollnick et al., 2001; Pogacnik & Cigic, 2006; Reid & Shah, 2007). Therefore, it could be worth considering implementing similar strategy at the Faculty of Health and Medical Sciences. Without acting too harsh, one could build on uploading a set of practical course-related questions on Absalon/Canvas to boost the discussion during the laboratory classes and motivate students to make an extra preparation effort or to make students to prepare/read the manual at all. The online pre-laboratory quiz approach was reported to enhance student preparedness and overall performance in the laboratory (Peteroy-Kelly, 2010).

It is evident, that the respondents prepare alone for the practical classes. This is not surprising as each student may need different amount of time to study and, in general, it is more difficult to decide on one common timeslot to prepare in the group, because of busy schedules. The performed analysis revealed that the main motivation for pre-laboratory preparation is to increase understanding in the class. This is uplifting as it indicates that students want to remain conscious during the classes, comprehend and benefit from the content. The most common, yet trivial, factor hindering the re-

spondents from pre-laboratory preparation turned out to be lack of time. This is however rather flippant excuse that could be minimised by forcing students to do any of the above-proposed entry activities.

Analysis of the data related to the "Kidney and the Urinary Tract" laboratory exercise showed that the level of preparation corresponded to the preparation for the practical courses held during the first four semesters, i.e., mostly insufficient. This correlates with my personal perception of the students that attended my classes. Again, online-based resources are not employed in preparation for this particular laboratory exercise. This could be easily improved by, e.g., supplying students with links to videos related to the content of the class. However, the respondents clearly agree that both provided laboratory manual and accompanying lectures are sufficient for the pre-laboratory preparation. Thus, it can be concluded that the low level of preparation is mainly due to lack of willingness/time to prepare, but not due to lack of relevant resources.

Conclusions

The results presented in this study show that medical students do not spend enough time on pre-laboratory preparation, resulting in only partial readiness for the practical classes. Moreover, students do not use online-based resources. Although the best form of preparation would vary from student to student and they master material at their own pace, it seems necessary to implement common motivational activities enhancing the pre-laboratory preparation, e.g., online quiz-based approach. Only well-prepared students can fully benefit from practical procedures designed to have meaningful impact on the understanding of the topics taught during the laboratory classes.

Figures

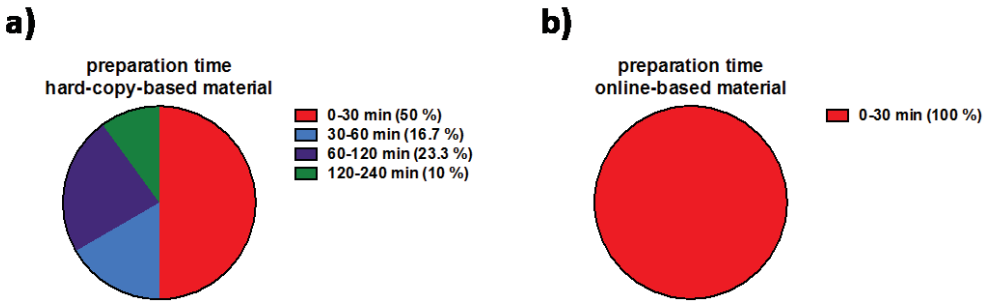

Fig. 5.1: Average preparation time spent by medical students before attending laboratory exercises held during first four semesters of their study program. Pie charts show % of distribution calculated for 30 respondents who selected exactly 1 out of 4 listed time durations (in minutes, min). See Appendix A, (Question 1) for details. a) Preparation time using hard-copy-based material. b) Preparation time using online-based material.

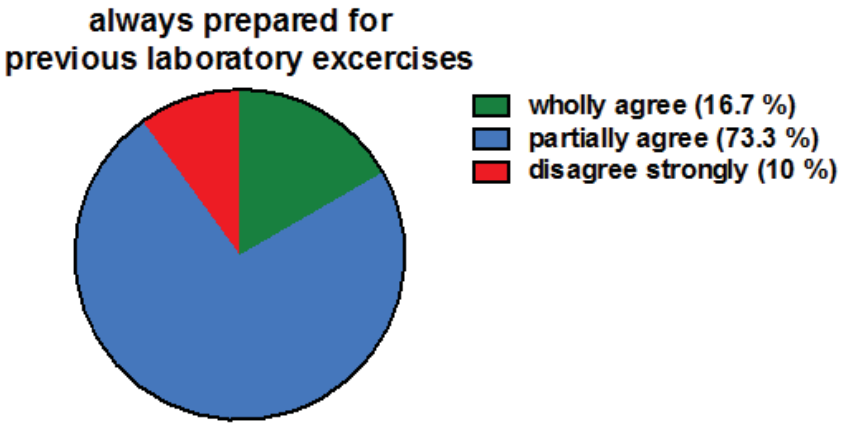

Fig. 5.2: Fraction of students considered themselves as being always prepared for the laboratory exercises. Pie chart shows % of distribution calculated for 30 respondents who selected exactly 1 out of 3 listed answers. See Appendix A, (Question 3) for details.

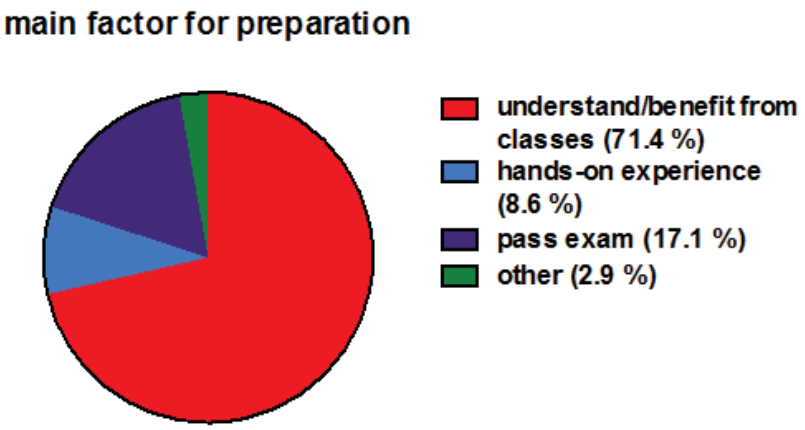

Fig. 5.3: Main factors motivating students to prepare for the laboratory exercises. Pie chart shows % of distribution calculated for 30 respondents who selected at least 1 out of 4 listed answers. See Appendix A, (Question 4) for details.

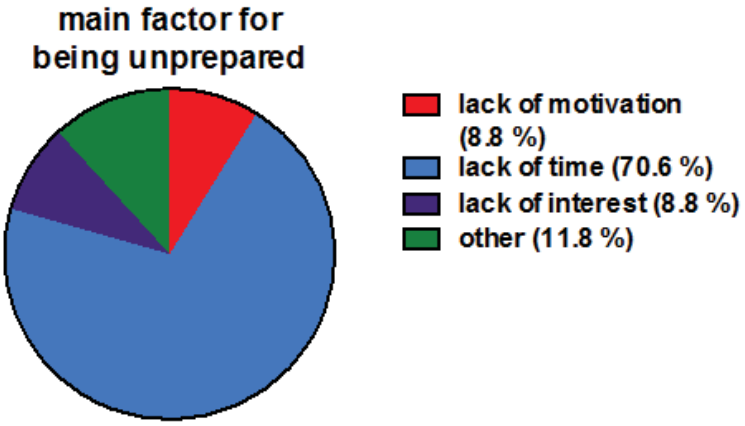

Fig. 5.4: Main factors responsible for lack of the pre-laboratory preparation. Pie chart shows % of distribution calculated for 30 respondents who selected at least 1 out of 4 listed answers. See Appendix A, (Question 5) for details.

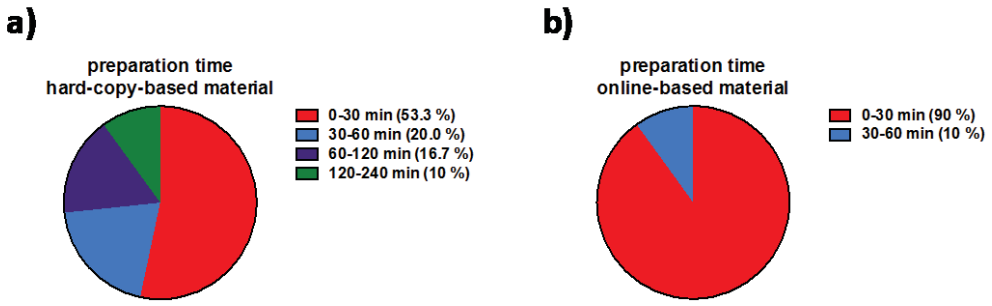

Fig. 5.5: Average preparation time spent by medical students before attending the practical part of "Kidney and the Urinary Tract" course. Pie charts show % of distribution calculated for 30 respondents who selected exactly 1 out of 4 listed time durations (in minutes, min). See Appendix A, (Question 6) for details. a) Preparation time using hard-copy-based material. b) Preparation time using online-based material.

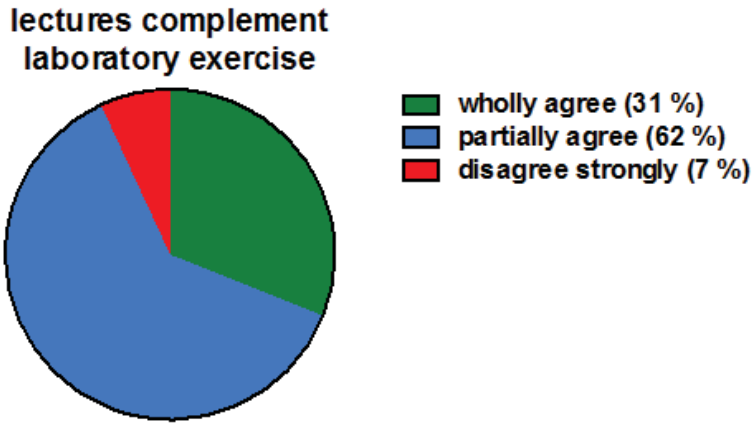

Fig. 5.6: Fraction of students considering lectures of "Kidney and the Urinary Tract" course helpful in preparing for the laboratory exercise. Pie chart shows % of distribution calculated for 30 respondents who selected exactly 1 out of 3 listed answers. See Appendix A, (Question 7) for details.

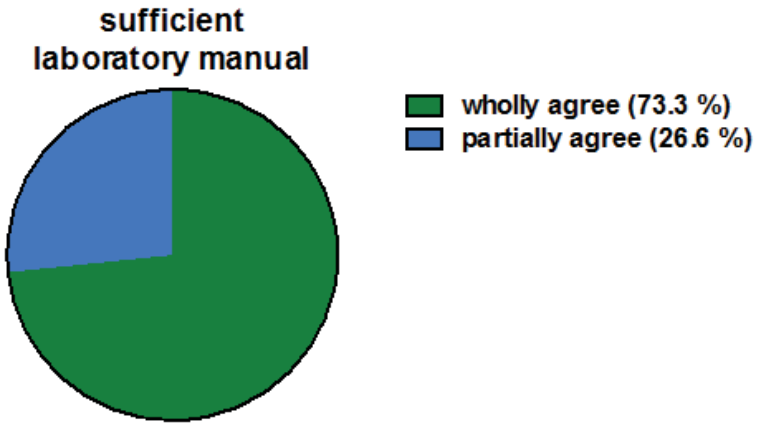

Fig. 5.7: Fraction of students considering laboratory manual of "Kidney and the Urinary Tract" practical course sufficient to prepare for the exercise. Pie chart shows % of distribution calculated for 30 respondents who selected exactly 1 out of 3 listed answers. See Appendix, A, Figure 1 (Question 8) for details.

A The questionnaire used for data collection in the present study

Pre-course preparation for the laboratory courses held in semesters 1-4

1. Previously, how much preparation would you typically complete before attending a laboratory exercise?
   a) hard-copy-based (e.g. reading laboratory manual, textbook)
      0-30 min, 30-60 min, 60-120 min, 120-240 min
   b) online-based (e.g. online course material if available, youtube-related videos)
      0-30 min, 30-60 min, 60-120 min, 120-240 min

2. How do you usually prepare before the laboratory course?
   a) alone (self-study)
   b) in a study group
   c) in other way:_____

3. I was always prepared for my previous laboratory exercises:
   wholly agree partially agree disagree strongly

4. What was the main factor to prepare firmly for a laboratory exercise?
   a) willingness to understand/benefit from the class as much as possible
   b) getting the best hands-on experience
   c) to pass as the practical exercise was needed to qualify for an exam
   d) other reason:_____

5. What was the main factor to show up unprepared for a laboratory exercise?
   a) lack of motivation
   b) lack of time
   c) lack of interest
   d) other reason:_____

Pre-course preparation for the laboratory course in kidney physiology

6. How much time did you spend for preparation for the laboratory exercise in kidney physiology?
   a) hard-copy-based (e.g. reading laboratory manual, textbook)
      0-30 min, 30-60 min, 60-120 min, 120-240 min
   b) online-based (e.g. online course material if available, youtube-related videos)
      0-30 min, 30-60 min, 60-120 min, 120-240 min

7. The accompanying lecture and the laboratory exercise complement each other and help to prepare for the practical course:
   wholly agree partially agree disagree strongly

8. Laboratory manual provided sufficient information to prepare for the exercise:
   wholly agree partially agree disagree strongly

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