

Assessing the prior knowledge and teaching a heterogeneous class of dental hygienist

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1. Introduction

A large body of research can be found on the type of classrooms (homogenous: consisting of students having similar educational levels, interests, ages, special needs, etc *versus* heterogenous: consisting of students having different educational levels, interests, ages, special needs, etc) and suggestions for various teaching methods to maximize the students' understanding (1, 2). A heterogeneous classroom poses a particular challenge for the teachers to maximize the benefit of teaching. The differences in the students prior knowledge (heterogeneity) has been linked to the performance of the students in future (3), and therefore special measures need to be implemented to understand the degree of heterogeneity in the students' prior knowledge and accordingly to manage the classroom teaching.

The dental hygienist education program at the Faculty of Medicine and Dentistry, University of Bergen (UiB) consists of students (approximately 30 students / year) coming from different parts of Norway with different educational backgrounds (with respect to the major subject in their high schools, grades obtained, etc), thus making these students a very heterogeneous group. It has also been felt by many teachers that several of these students have a significant knowledge gap in some of the subjects when they start dental hygienist education program. Heterogeneity and knowledge gap in some of the subjects have been felt to be the contributing factors for their varied performance in the exams. In parallel, Seery MK has also suggested that prior knowledge in chemistry had a strong influence on the performance of first year undergraduate students in the exams (4). This pilot project attempted to access the

prior knowledge on selected topics on physiology course (TPBAFYS, credit points: 5) of a second semester dental hygienist students and to implement specific measures during lectures to maximize students' understanding.

2. Aims

This project had the following aims:

1. To access the prior knowledge of the dental hygienist students by using a set of multiple-choice questions (*pre - test*) covering the topics to be taught.
2. To modify / re - organize the lecture based on the prior knowledge of the students.
3. To access the general understanding of the students at the end of the lectures by using in-depth multiple-choice questionnaire (*post - test*) covering the taught topics.

3. Methodology

3.1. Study population.

The study population consisted of dental hygienist students in the second semester of their education at the Faculty of Medicine and Dentistry, University of Bergen. The participation was on a voluntary basis. All of the students were explained about the aims of the study and were ensured about their anonymity. Seventeen and fourteen students participated respectively to the '*pre - and post - tests*'.

3.2. Pre-test of students.

Ten multiple-choice questions covering the general/basic knowledge on the topics to be taught (topics on physiology course) were distributed to the students at the beginning of the first lecture. Each multiple-choice question consisted of 3-5 alternative answers. Students were asked to answer the questions individually and not in groups. There was no restriction on the time to answer the questionnaires. In total, 17 students participated to the *pre - test*. Below are two examples of the *pre - test* questionnaires used in the project.

Questionnaire 1: The most important components of the sensory system are

- a. Stimulus + sensory cells + sensory nerve fibers + central nervous system (cerebral cortex)
- b. Stimulus + sensory cells + motor nerve fibers + central nervous system (cerebral cortex)
- c. Stimulus + sensory nerve fibers + central nervous system (cerebral cortex)

Questionnaire 2: Sensory cells responsible for the smell sense are found in

- a. Sensory epithelium in the nasal cavity
- b. Sensory area in the brain
- c. Sensory nerve
- d. All of the above

3.3. Intervention: modification / re - organization of the lectures based on the performance of the students to the pre - test.

The performances of individual students were analyzed and the subsequent lectures were or / re-organized so that as many as students will be able to understand the taught topics. Special focus was given for the topics where most of the students had an overall poor prior knowledge. For example, those topics were given relatively more time for classroom teaching than other topics where students had a better overall basic understanding. The following interventions were carried out:

- (i) more simplified illustrations were used (simpler PowerPoint slides including the only necessary information were used, information was simplified by drawing illustrations using the blackboard). Students were encouraged to interact during the lectures (follow-up questions were asked in the classroom and students were given some time to think and answer these questions).
- (ii) complex information was repeated (a brief simplified summary of complex information was given) at the end of the lecture as well as at the beginning of the following lecture.

3.4. Post - test of students after the intervention.

To examine the understanding of the students after the intervention, *post - test* (consisting of 10 questionnaires) was conducted at the end of the last lecture. The *post - test* was designed in such a way that it consisted of the same four questions (for which most of the students performed poorly) from the *pre - test* and six new questionnaires were in-depth questionnaires for most of the topics covered previously by the six multiple-choice questionnaires of the *pre - test* (Fig. 1). The students had a mixed performance for the 6 questionnaires in the *pre - test*.

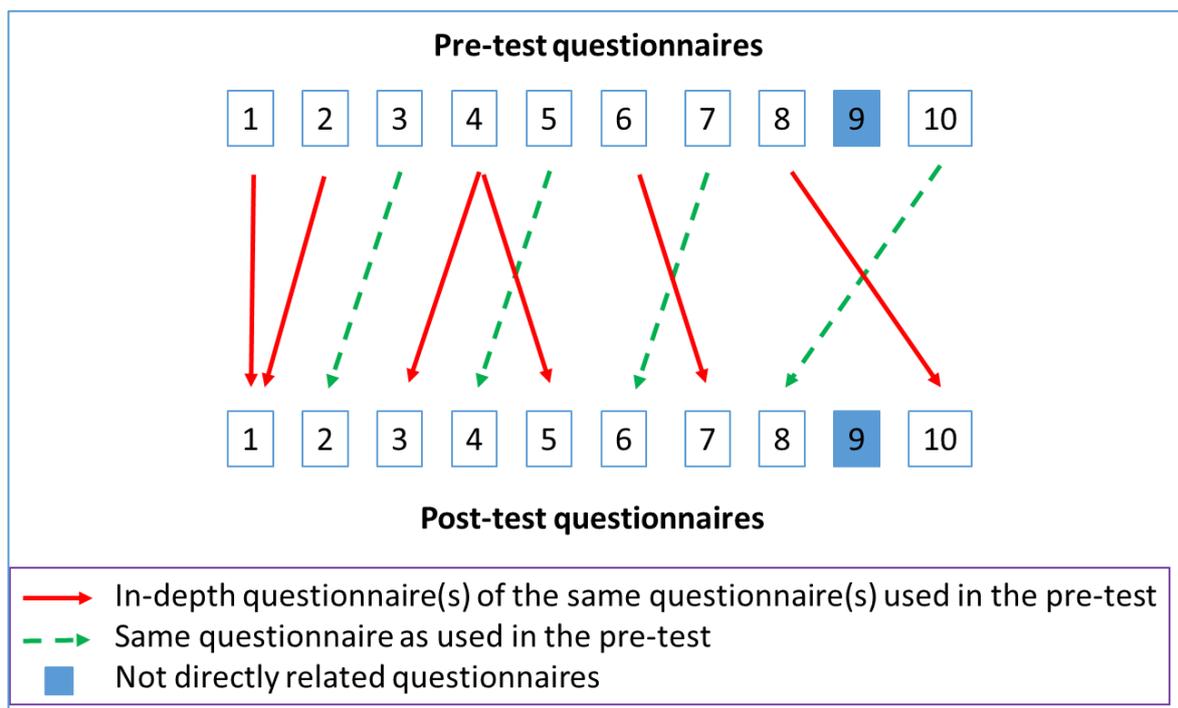


Fig 1. Figure illustrating the strategy used to design the *pre-* and *post-tests* of the project.

3.3. Data analysis

The dichotomous data (correct vs incorrect answers) from both the '*pre - and post - tests*' were entered in GraphPad Prism (version 7.02) for Windows and percentage and mode of correct answers for each questionnaire was calculated.

4. Results and discussion

4.1. Prior knowledge of students on the topics to be taught.

As expected, the prior knowledge of dental hygienist students on the topics to be taught was highly variable, with mode of the correct answers for the *pre - test* being 50%. As shown in Fig. 2A, 8 (44 %) of the students answered >50 % of the *pre - test* questions correctly, whereas 9 (56 %) of the students managed only ≤ 50 %. It is worth mentioning that two (12%) of the students answered 90% of the questions correctly. Taken into consideration of the fact that these students have a heterogeneous academic backgrounds (with respect to the major subject when graduated from the high school and grades) when they enrolled the dental hygienist study, the observed variation in the performance of students to the *pre-test* is not a surprising one.

Looking at the individual questions from the *pre-test*, 50% of the questions were correctly answered by >50 % of the students (Fig 2B). This indicates that the majority of the students had a reasonable prior overview of some of the topics, whereas other topics seemed to be less familiar to the most of the students. One of the explanations for this variation could be the incorporation of new or more detailed topics to the dental hygienist education as compared to the prior knowledge (knowledge gap) of the dental hygienist students.

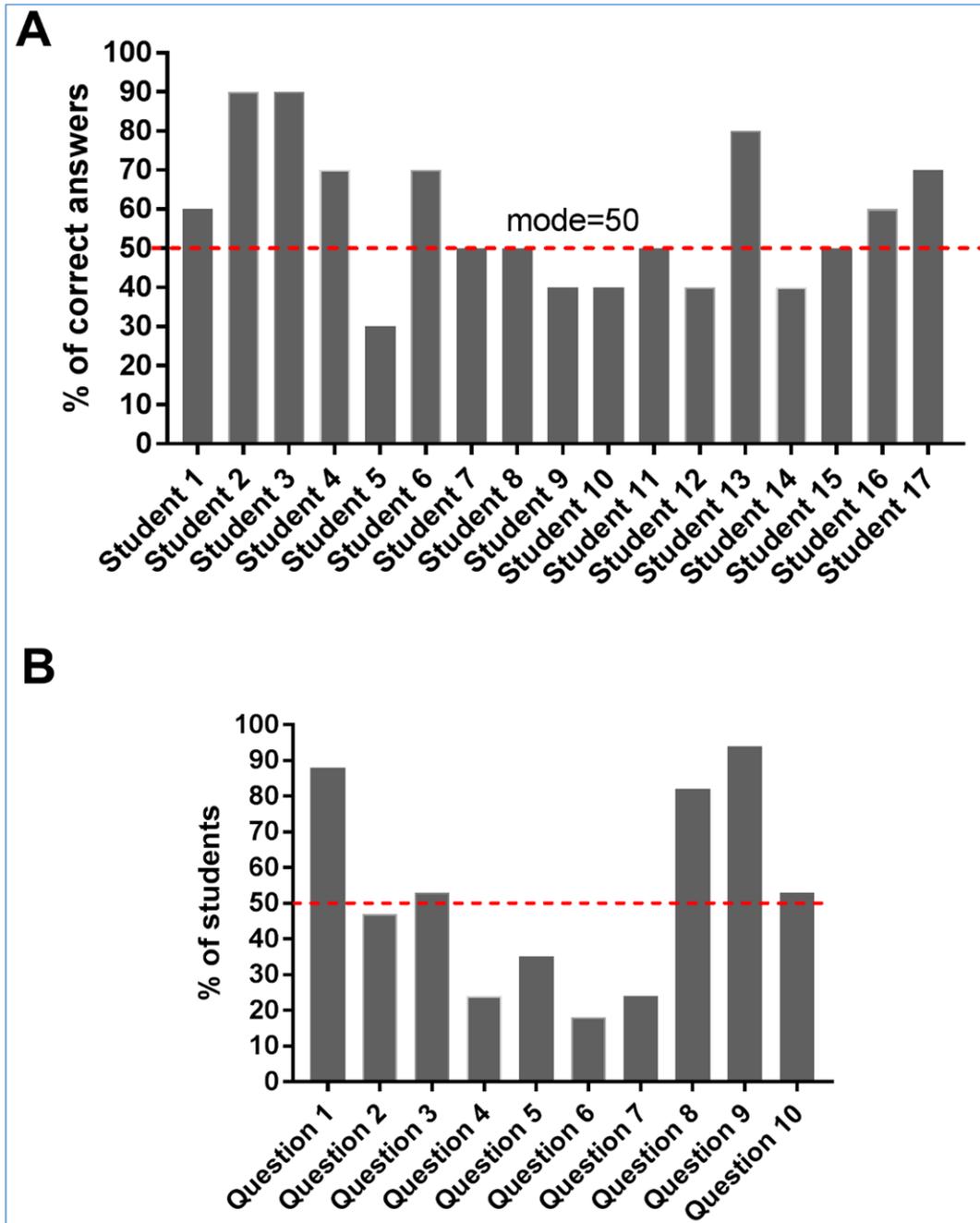


Fig 2. Figure demonstrating the percentage of correct answers for each student (A) and percentages of students who correctly answered each question (B) in the *pre - test*.

4.2. Effect of intervention on the knowledge of students on the topics

Based on the performance of the students to the *pre - test*, a number of modifications were made to the following lectures as mentioned in the methodology section. Effect of

intervention was next examined by using the *post - test*. As we can see from the Fig. 3, the mode of the correct answers after the *post - test* was 60%. 11 (79 %) of the students answered $\geq 50\%$ of the *post - test* questions correctly, whereas only 3 (21 %) of the students managed only $\leq 50\%$. These observations show that majority of the students performed better after the lectures modified according to the students prior-knowledge on the topics.

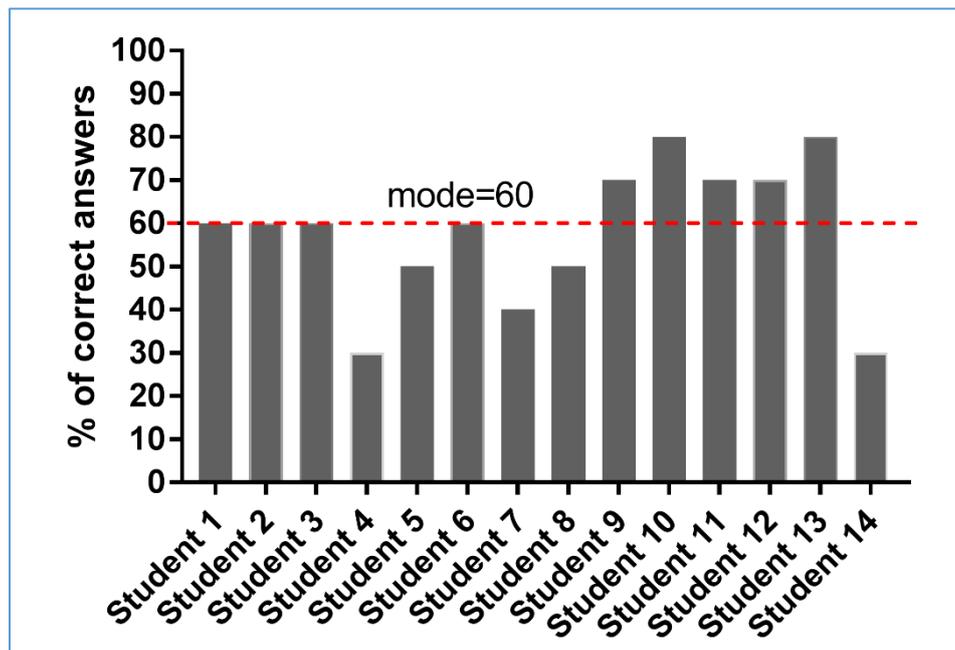


Fig 3. Figure demonstrating the percentages of correct answers for each student (A) in the *post -test*.

In an attempt to investigate the effect of the intervention on the topics where most of the students performed poorly in the *pre - test*, four of the questions from the *pre - test* were repeated also in the *post - test*. As, we can see in the Fig 4A, percentage of the correct answers for all of these questions (Q3, Q5, Q7 and Q10) had increased after the intervention. This suggests that the intervention was effective enough to make the students understand the more complicated information in the lecture. A similar comparison for the *pre-test* questionnaires for which more in-depth questionnaires were used in the *post-test*, however, showed a mixed outcome (Fig. 4B). For example, for the two of the *pre-test* questionnaires (Q2 and Q4) the students performed relatively better in the *post-test*, whereas for the two other questionnaires

(Q8 and Q6), the performance was not improved. Some of the possible explanations for this variation could be that: i) the classroom teaching these particular topics was not as effective as for the other topics or ii) the in-depth questionnaires used were too difficult for the students. Additionally, possibility of students memorizing the repeated questionnaires in the *pre-* and the *post-test* can not be completely ruled out.

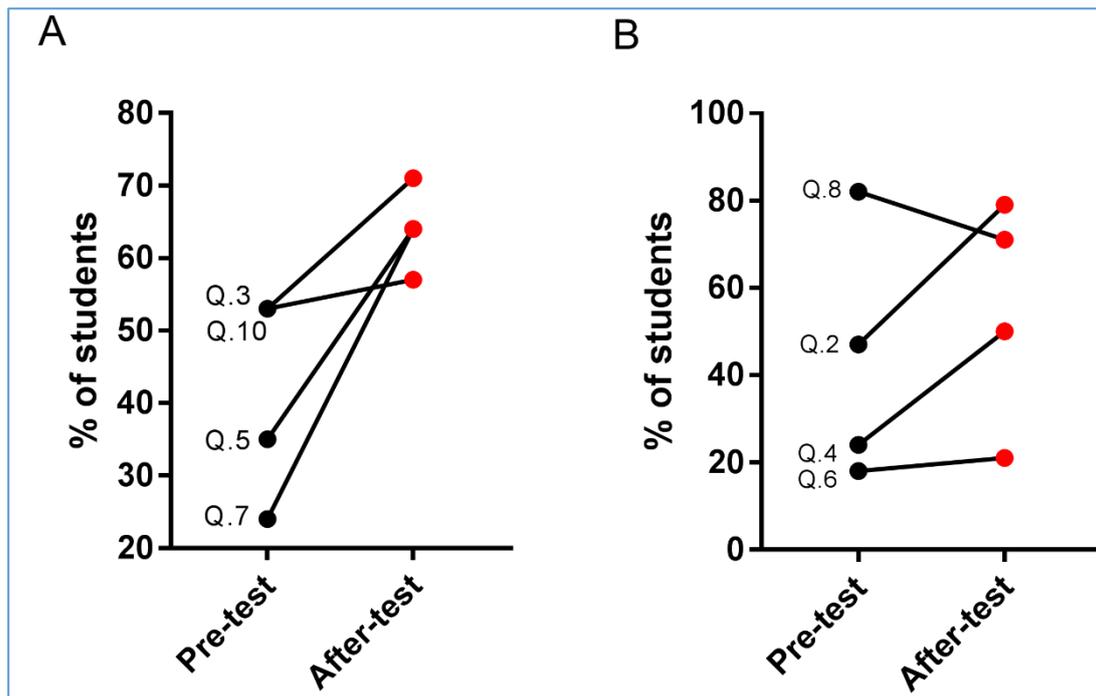


Fig 4. Figure demonstrating the percentages of students who correctly answered four common questionnaires in the *pre-* and *post-tests* (A) and four related in-depth questionnaires in the *post-test* (B).

5. Some reflections on the students' performance after the intervention.

The overall performance of the students after intervention was satisfactory and this encourages me to utilize the interventions used in the current project for my future teaching duties for a heterogeneous classroom. Specially, it was a good surprise for me to know that students appreciated the 'old-fashioned' blackboard teaching. I feel that, if used intelligently, the blackboard teaching helps to convey a more complicated information in a simpler way and students get more time to focus on and to absorb the information. I am relatively satisfied with

the students' participation in the teaching. Almost half of the students seemed to participate actively in the classroom. However, I feel that dividing students into working groups might increase their participation.

One of the interesting observations of this project was that students performed relatively better after interventions for some of the topics where they performed poorly in the *pre - test* (Fig. 4A). However, it is worth mentioning that the performance for Q10 was not as good as for other questionnaires (Q3, Q5 and Q7). I do not have a clear explanation for this result. Nevertheless, I can not completely rule out the influence of the the two apparently very similar answer options used for Q10.

6. Limitation of the current study and suggestions for future studies.

The results of this pilot project suggest that modification / organization of the lecture according to the prior knowledge of a heterogeneous dental hygienist class is helpful to make students understand better. However, there are a number of limitations of the study, which are worth mentioning. Firstly, the *pre - test* was done at the beginning of the first lecture and this made it impossible to intervene the very first lecture based on the results of the *pre-test*. Hence, it is advisable to conduct the *pre - test* at least a few days in advance of the first lecture. Secondly, number of the students participating in the *pre -* and *post - test* was relatively smaller (17 vs 14). This makes it difficult to generalize the findings of this project to a classroom with a large number of students. Thirdly, as the student attendance in the lecture was not obligatory, number of students attending the lectures was variable from one lecture to another. It was felt that some of the students who were absent in the previous lectures, attended the last lecture and participated in the *post - test*. It can be argued that this might have negatively affected the results of the *post - test*. Hence, participation of the same students to both *pre-* and *post-test* is desirable to examine the effect of the intervention more precisely. One of the possible solutions for this issue is to include some extra questions

related to the student attendance in the *post-test* (for example, which of the topics did you attend the classroom?). *To document the heterogeneity of the students included in this project, the author requested the anonymized details on the academic qualifications, major subjects and grades of the student from the student administration at UiB, but it was not possible to get these information.*

7. Conclusions

The findings of the current pilot project suggest the prior knowledge of the dental hygienist students (a heterogeneous group of students) on topics on physiology course was variable among students. Information on prior knowledge of these students can be used to modify / re - organize of the lectures to help students understand the taught topics better.

7. References

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