

Evaluating the use of a student response system in high enrollment anatomy lectures

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Abstract

Student response systems¹ (SRS) are devices or software that allow students to provide responses to questions embedded within a lecture, which can then be automatically summarized to provide immediate feedback to the students and/or teachers (Wieman *et al.*, 2008; Mathiasen, 2013; Vicens, 2013).

I recently used an SRS, Shakespeak®, for my lectures in Anatomy in the course Exercise Physiology 1 at the Department of Nutrition, Exercise and Sports, University of Copenhagen. Anatomy lectures are often thought to be dull and full of details and difficult names, and with 136 students in the course it can be challenging to engage and interact with the students. The aim of this project was to evaluate the use of Shakespeak® based on student feedback from a questionnaire and a focus group interview.

Questionnaire results showed that 99% of respondent liked the quizzes, while 88% thought that they helped them to remember the content of the lectures. About 55% believed that the quizzes influenced how they studied after a lecture and 72% felt better prepared for the exam. Qualitative analyses of the students' open-ended responses in the questionnaire and comments from the focus group interview provided support and additional insights for the quantitative analyses.

Overall, the Shakespeak® quizzes were popular with the students, and they made the course more engaging and motivating. The quizzes helped the students to retain information and prepare them for the exam, and the students wished that they would also be used in courses other than just Anatomy.

Introduction

Most textbooks claim that students learn by actively processing the information (Biggs & Tang, 2011). Nevertheless, the most common form of teaching in University settings, lectures, are often criticized for leaving the students as passive recipients of knowledge and being too tedious to sustain students' attention. But is it at all possible to activate students in lectures with a high enrollment? I was recently faced with this challenge, as I was assigned a weekly 2-hour anatomy lecture for the first year students in the course Exercise Physiology 1 – a course with approximately 140 students.

To deal with this challenge, I first interviewed a focus group of second year students, who had taken the course the previous year, about the use of and challenges with

¹ The literature uses many names for these devices or systems, such as "Clickers", "Electronic Voting Systems", "Audience Paced Feedback" etc.

student-activating activities in large classes both in general and in this course specifically². The main points were that the students want to (and expect to) be activated in lectures³, but that the main barrier for their participation is fear of embarrassment. Towards the end of the focus group interview, we introduced them to the use of Shakespeak® quizzes to overcome these barriers. Shakespeak® is a web- and SMS-based SRS that can be used as a pedagogical tool to activate students in the lecture hall. The teacher can pose a question and immediately see the students' responses⁴. The students respond, anonymously, via SMS, Internet or Twitter.

As the feedback from the focus group was very positive, I decided to explore the use of Shakespeak® quizzes in my lectures in Exercise Physiology 1. I typically exposed the students to a total of 4-6 quiz questions during a 2-hour lecture in 2-3 sessions with 1-3 questions in a row. A quiz session about the topic of the previous week was usually placed in the beginning of the lecture to repeat important points (Roediger & Butler, 2011). Sometimes a session was placed mid-way if the topic was particularly difficult to comprehend or if I did not have other breaks or activities to sustain the students' attention (Dahl & Troelsen, 2013). There was always a session at the end of the lecture to sum up the main points. Types of questions used included both simple recall of lecture points (figure 1) and tests of conceptual understanding. The quizzes involved both simple votes and 'think-pair-share' where students were first given time to think on their own, then invited to pair with a neighbor to discuss their reasoning and finally asked to vote. This structure was inspired by the literature on the use of SRSs (Beatty *et al.*, 2006; Caldwell, 2007; Wieman *et al.*, 2008; Vicens, 2013) and tailored to fit the intended learning outcomes of the course.



Figure 1. An example of a simple recall Shakespeak® question (left) and distribution of the 119 votes in the following slide (right). This was asked in the very first Anatomy lecture. When vote distributions like these appeared, students were often asked to discuss with their peers after which the vote would be repeated.

The aim of the present project was to evaluate the use of Shakespeak® quizzes in these lectures through student feedback. More specifically:

- Did they like the quizzes and if so, why?
- Did the quizzes influence how they studied before and after lectures? And what they remembered from lectures?
- Did they feel that the quizzes better prepared them for the exam?

² This was performed as part of our Universitetspædagogikum pre-project

³ "The more things I need to think about – the more I feel I learn." Comment from student C in the focus group interview

⁴ Shakespeak® is integrated into PowerPoint® and the distribution of answers automatically pops up on the following slide

Methods

To address these questions, at the end of the course I asked the students to fill out an anonymous, electronic questionnaire consisting of 10 questions and an open-ended comment box (see Appendix A for questions in Danish). The students received an email with a link to the questionnaire the day before the last lecture and were asked to respond within a week. For question 3-8, the students were asked to rate how much they agreed with the statement on a scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree). For simplicity reasons, ratings of 1 and 2 are interpreted as disagree, 3 as neutral and 4 and 5 as agree.

In order to supplement the quantitative feedback from the questionnaire with qualitative feedback, I conducted a 60-min focus group interview with 7 students from the course. The interview was recorded simultaneously on a video camera and on an iPhone 4 with the Voice Memos application. After the interview, all comments from the focus group were typed in to an excel spreadsheet. I did not attempt to quantify the responses, but have quoted some of the representative comments in the text.

Some of the interview questions were based on the results of the questionnaire, e.g. *“In the questionnaire, 99% respond that they like the quizzes. Can you explain what you like about them? What type of questions do you prefer?”* Other questions were directed more towards their preparation, e.g. *“Did the Shakespeare quizzes influence how you prepared [before a lecture]? How?”* The focus group questions are summarized in Appendix B (in Danish).

All questions and comments from students were originally in Danish, and have only been translated to English when used in this paper.

Results

Out of the 136 students following the course, 97 responded before the deadline. Figure 2 shows that 92% of the respondents attended all or nearly all of the anatomy lectures (5 or 6 of the 2-hour lectures), which indicates that they have regularly been exposed to the Shakespeare® quizzes.

How many of the 6 anatomy lectures did you attend?

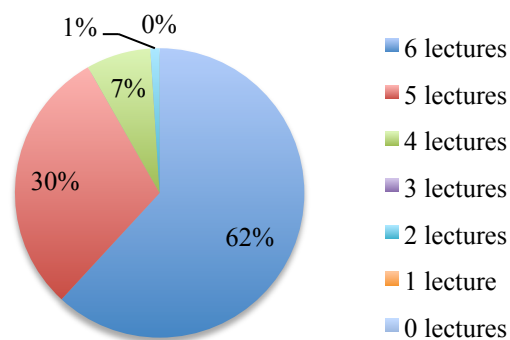


Figure 2. Number of lectures attended by the respondents (n = 97).

Table 1 gives an overview of the responses to the questions where the students had to rate how strongly they disagreed or agreed with the statement. For 84% of the students it was the first time that they had tried SRS quizzes (data not shown) and 99% agreed that they liked the Shakespeare quizzes while 88% agreed that it helped them to remember the content of the lecture.

An open-ended comment from a student supports this view: *“A really good way to activate a whole lecture hall! It can often be difficult to stay focused, but if you are given a task to reflect about the content of the lecture it improves learning, at least in my case. Keep up the good work!”*

Another student commented: *“The quizzes made the lectures more alive, and engaged us much more than regular lectures. A superb initiative.”*

Table 1. Distribution of responses (n = 97) to the questions where the students had to rate how much they agreed or disagreed with the statements on a scale from 1 to 5 (1 = strongly disagree, 5 = strongly agree).

Questions: 1 = strongly disagree 5 = strongly agree	1	2	3	4	5	Average
I liked the Shakespeare quizzes	0%	0%	1%	13%	86%	4.8
The Shakespeare quizzes helped me remember the content of the lecture	0%	2%	10%	37%	51%	4.4
The Shakespeare quizzes influenced how I studied (e.g. what I focused on) after a lecture	4%	14%	26%	35%	20%	3.5
The Shakespeare quizzes made me feel better prepared for the exam	3%	3%	21%	37%	35%	4.0
I wish that Shakespeare quizzes would also be used in lectures in other courses than anatomy	0%	3%	10%	42%	44%	4.7

An often heavily debated point is student preparation. From the questionnaire it appears that 57% of students study for all or nearly all lectures, whereas 15% prepare only a few times or never (figure 3), but I was curious to see if Shakespeare® quizzes might have influenced how the students prepared for the lectures. I therefore asked the focus group: *“Did the Shakespeare quizzes influence how you prepared [before a lecture]? How?”*

There was a general agreement that the quizzes did not directly influence how they studied for a lecture, although student E commented that it might affect him subconsciously: *“...but subconsciously. I want to study for this lecture because I know that it doesn't bore me to death, because you actually become involved and have to decide on something.”* However, student G commented that: *“I think it has a bigger effect on how you study after a lecture than before,”* which everyone in the focus group then agreed with.

Indeed, 55% of questionnaire respondents agreed that the quizzes influenced how they studied after a lecture (table 1). Comments from the focus group indicated that it helped them to focus their reading after lectures. This was both in terms of what was important, but also in that it gave them feedback on what they had understood and what they needed to focus more on. Student A: *“...and if you don't get it right, you think, at least I do, then I HAVE got home [and study] and it HAS to be there tomorrow.”*

How often did you prepare (study) for the anatomy lectures?

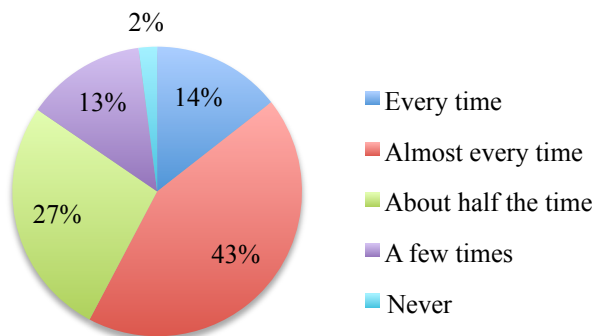


Figure 3. Pie chart showing how often students prepared for anatomy lectures (n = 97).

What about the amount of questions during a lecture? Since this was my first time using Shakespeak® quizzes during lectures I was not sure about how many questions to ask during a lecture. Just under half of the respondents (47%) would have liked more questions whereas the rest (53%) thought that the amount was appropriate. No students responded that they would have liked fewer questions (data not shown). Comments from the focus group was mainly in favor of ‘appropriate’, and some said that more questions would have taken too much time away from the rest of the lecture, and that there is always a bit of noise after a quiz.

Discussion

It has previously been shown that SRSs can increase the engagement, motivation and learning in high enrollment chemistry lectures (Hall *et al.*, 2005). Many students in this study also mentioned increased motivation, engagement and retention of information, as some of the positive effects of Shakespeak® quizzes. From the focus group, student G said: *“It creates a motivation to stay focused and it makes it easier to remember afterwards.”* And an open-ended comment from the questionnaire stated: *“Keep using it. It works really well and it is fun! The students wake up and participate in the teaching and it is nice to get feedback on whether you have understood it correctly. Big fan 😊”*

Another student commented: *“Shakespeak demanded that you, as a student, had to be active during lectures, which created a more dynamic learning environment. Lectures are usually experienced as passive learning for the student, which is often demotivating.”* There is no doubt that by activating students with a question, several good things happen. It focuses the students’ attention on the important facts or ideas and it allows students to try applying the ideas that they just heard or read about. According to student comments, questions with peer discussion before voting seem to be especially effective in this: *“Excellent tool. Good when the students stick their heads together and discuss. Then you typically remember what was discussed. Great tool and good lectures.”* This has also been indicated in former studies (Kristensen, 2012).

Another study evaluating the use of SRSs at 8 different departments over the course of two years with group sizes of 12-300 students found that across disciplines benefits outweigh disadvantages (Draper & Brown, 2004). Improvements in attendance has also

been observed in previous studies (Caldwell, 2007) and although it is not possible to conclude if the attendance rate was influenced by the use of Shakespeak® in the present study it is impressive that 92% of respondents attended all or nearly all lectures.

It is remarkable that 72% replied that the quizzes made them feel better prepared for the exam. Here it is important to keep in mind that the course, Exercise Physiology 1, ends with a multiple choice questions (MCQ) exam, which resembles the format of the quizzes that I have used in my lectures⁵ and is therefore nicely aligned. In a study by Karpicke & Roediger (2008), it was shown that retrieval practice is of critical importance for the consolidation of learning. After learning foreign vocabulary words, students that were repeatedly tested without further studying had a large positive effect on delayed recall, which was not observed in students that repeatedly studied the vocabulary items without further testing (Karpicke & Roediger, 2008). Although one might argue that 'recall' belongs at the bottom of the SOLO-taxonomy (Biggs & Tang, 2011), recalling (naming) is still part of the learning objectives in anatomy. While difficult to compare, it is interesting that the results of the anatomy part of the final exam showed that the students scored $67 \pm 14\%$ (mean \pm SD), which is significantly better than the score of $45 \pm 19\%$ in the previous year ($P < 0.001$). It is impossible to determine if the Shakespeak® quizzes contributed to this difference, as the exam questions were not the same and because many other changes were also introduced to the course. Nevertheless, it is something that should be investigated in future studies.

Deep learning also requires the active processing of information, and a passive reading of material or knowledge transfer through teacher monologue is simply not enough. I believe that Shakespeak quizzes can provide a helpful tool to engage the students in this process. In support of this, 86% wished that Shakespeak quizzes would also be used in lectures in courses other than just Anatomy. How could Shakespeak® quizzes then be organized in courses that use different types of final exams to allow for constructive alignment? I recently taught the course Exercise Physiology 2 that ends with an oral exam. In those lectures, I always instructed the students to discuss with their peers before voting and emphasized the importance of this, as they would soon have to argue their points at the exam.

Conclusions and perspectives

Overall, students liked the Shakespeak® quizzes and found that they made the course more engaging and motivating, and helped them to remember the content of the lectures. The quizzes did generally not affect how they studied before a lecture, but 55% indicated that it influenced how they studied after a lecture, and 72% stated that it made them feel better prepared for the exam. While exam results were significantly better than the previous year, future studies should specifically investigate if SRSs can contribute to improved student performance in Anatomy.

The Nobel Prize winning author, Albert Camus, once said: "*Some people talk in their sleep. Lecturers talk while other people sleep.*" I believe that SRSs like Shakespeak® can help with the second part of the quote and should therefore be used in lectures to sustain students' attention and help them to actively process the information to increase learning.

⁵ An important difference is that Shakespeak® allows only one correct answer whereas the final exam can have up to 5 correct answers to each question

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Appendix A: Questionnaire used for evaluation of the use of Shakespeare in Exercise Physiology 1

Shakespeare quiz-spørgsmål i forelæsninger

Kære studerende.

Jeg skal til at skrive min afsluttende opgave i Universitetspædagogikum og håber I vil hjælpe mig ved at udfylde dette spørgeskema (10 spørgsmål) om brugen af Shakespeare quiz-spørgsmål i anatomi-forelæsningerne i Arbejdsfysiologi 1. Jeg vil bruge jeres svar til opgaven, men også til at forbedre dette og andre kurser fremover.

Jeres svar er anonyme.

Anatomi-forelæsningerne generelt

1) Hvor mange af de 6 anatomi-forelæsninger i Arbejdsfysiologi 1 har du været til?

(hvis du er i tvivl, så markér det antal du tror)

- 0 forelæsninger (ingen af forelæsningerne)
- 1 forelæsning
- 2 forelæsninger
- 3 forelæsninger
- 4 forelæsninger
- 5 forelæsninger
- 6 forelæsninger (alle forelæsninger)

2) Hvor ofte forberedte du dig inden anatomi-forelæsningerne?

(fx ved at læse foreslået litteratur/pensum)

- Hver gang
- Næsten hver gang
- Ca. halvdelen af gangene
- Nogle få gange
- Aldrig

3) Forelæsningerne i anatomi har bidraget til min læring i kurset

(markér det tal mellem 1 og 5, som angiver hvor enig du er i ovenstående udsagn)

1 2 3 4 5

Slet ikke I høj grad

Shakespeare quiz-spørgsmål

4) Jeg kunne lide Shakespeare quizzerne

(markér det tal mellem 1 og 5, som angiver hvor enig du er i ovenstående udsagn)

1 2 3 4 5

Slet ikke I høj grad

5) Shakespeare quizzerne gjorde at jeg bedre huskede det der blev forelæst om

(markér det tal mellem 1 og 5, som angiver hvor enig du er i ovenstående udsagn)

1 2 3 4 5

Slet ikke I høj grad

6) Shakespeare quizzerne havde indflydelse på hvordan jeg læste (fx hvad jeg fokuserede på efter en forelæsning)

(markér det tal mellem 1 og 5, som angiver hvor enig du er i ovenstående udsagn)

1 2 3 4 5

Slet ikke I høj grad

7) Shakespeare quizzerne gjorde at jeg følte mig bedre forberedt til eksamen

(markér det tal mellem 1 og 5, som angiver hvor enig du er i ovenstående udsagn)

1 2 3 4 5

Slet ikke I høj grad

8) Jeg synes at antallet af Shakespeare quiz-spørgsmål i forelæsningerne var:

(markér det svar der passer bedst med ovenstående udsagn)

- For få (jeg vil gerne have haft flere)
- Passende
- For mange (jeg ville gerne have haft færre)

9) Jeg ville ønske at Shakespeare quizzer også blev brugt i forelæsninger i andre fag end anatomi

(markér det tal mellem 1 og 5, som angiver hvor enig du er i ovenstående udsagn)

1 2 3 4 5

Slet ikke I høj grad

10) I anatomi-forelæsningerne i Arbejdsfysiologi 1 var det første gang jeg prøvede quiz-spørgsmål med anonyme, elektroniske stemme-systemer (som fx Shakespeare og Clickers) i forelæsninger

- Ja
- Nej

Kommentarer og/eller gode råd til brugen af Shakespeare i forelæsninger?



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Appendix B: Summary of questions used in the focus group interview

1. **Opvarmning:** Vil I på skift introducere jer selv
2. Hvad var jeres oplevelse af anatomi-forelæsningerne i kurset?
 - a. Hvad var godt?
 - b. Hvad synes I kunne være bedre?
3. I spørgeskemaet svarer 99% af jer, at I kan lide Shakespeak quizzerne. Kan I sætte nogle ord på hvad I kan lide ved dem?
 - a. Hvilke typer af spørgsmål kan I bedst lide?
 - b. Hvilke typer af spørgsmål får I mest ud af?
 - c. Hvordan tror I det påvirkede jeres udbytte af forelæsningerne?
4. Hvordan forberedte I jer typisk inden en forelæsning i anatomi?
 - a. Havde Shakespeak quizzerne indflydelse på hvordan I forberedte jer?
 - i. Hvordan?
 - b. Hvad med efter en forelæsning. Hvordan læste I der?
 - i. Havde Shakespeak quizzerne indflydelse på det?
 - c. Tror I at I ville forberede jer anderledes før og efter, hvis der var mange flere quiz-spørgsmål i forelæsningerne?
 - i. Hvordan?
 - ii. Hvorfor?
5. Gjorde Shakespeak quizzerne at I blev mere klar på, hvad der forventedes af jer rent fagligt?
 - a. Og ift. forventninger til niveauet ved eksamen?
6. Mange undervisere taler om, at bærbare og smartphones bliver brugt til ikke-faglige aktiviteter (fx facebook) under forelæsningerne.
 - a. Oplever I at Shakespeak får jer til at fokusere mere på det faglige indhold og væk fra de ikke-faglige sysler (facebook m.m.)?
7. Brugen af Shakespeak quizzes tager tid væk fra resten af stoffet. Hvad er jeres holdning til det?
 - a. Er det et problem?
 - i. Hvorfor/hvorfor ikke?
8. I denne blok bliver der ikke stillet så mange MC quiz spørgsmål, men i stedet bruges message funktionen. Hvad er jeres holdning til det?
 - a. Hvordan synes I at formen kunne optimeres i denne blok (når det er mundtlig eksamen)?
9. Har I yderligere kommentarer?

10. **Forelæsningen som en mere aktiv undervisningsform:** Traditionelt set betragtes forelæsningen som en passiv undervisningsform, hvor den studerende "kan slappe af" og lære ved at lytte og notere. Der kan derfor hurtigt opstå en forventning fra de studerende om, at han/hun kan være passiv, hvor clicker-formen er aktiv og involverende.
 - a. Er de studerende omstillingsparate og klar til at tage det skift sammen med dig som underviser?