

Clickers in Education - do student's perceptions of clickers differ with the purpose?

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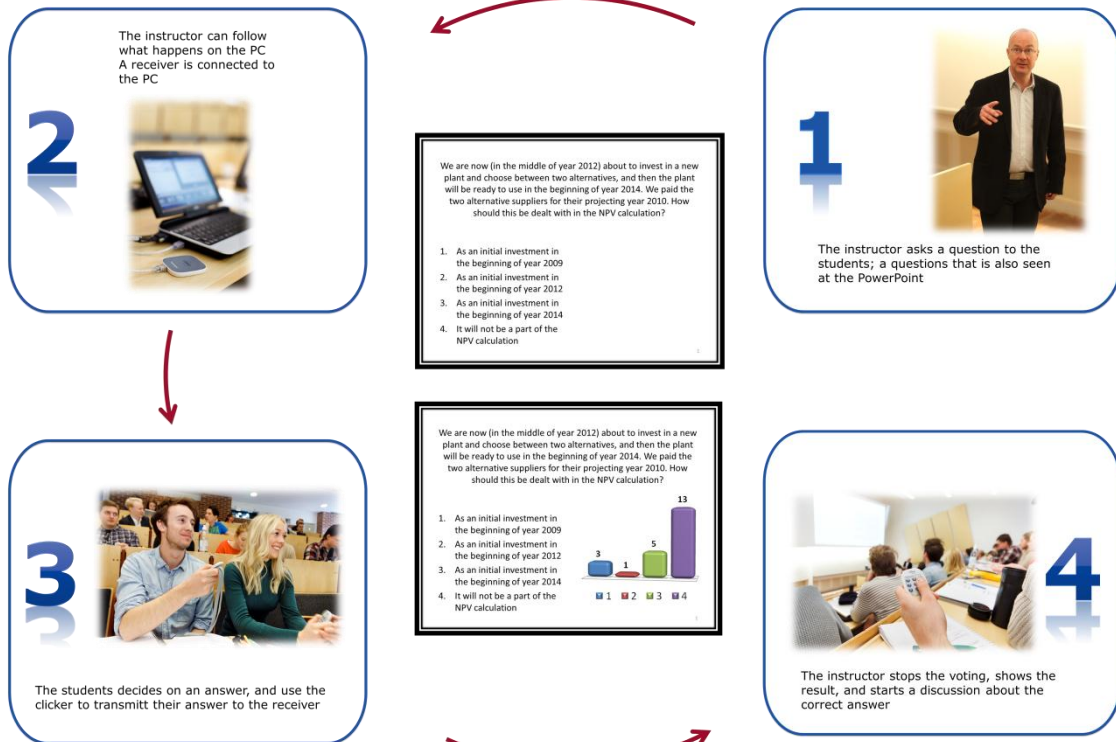
Abstract

How can we encourage student participation in large classes? More specifically, how can participation best be encouraged with clickers; if they are used with anonymity for the student, or if the teacher can track each student and her/his performance? In this study, we evaluated student's experiences of clickers in two settings; one where students used clickers anonymously, and one where clickers were used both for controlling attendance and as a part of setting the grade for the student in the course. We found pros and cons of both approaches. It seems that students are more satisfied and learn more from clickers' activities as such when used without control, but that students that have experienced control are more positive to this and that the control as such can force them to participate more in the lectures and, by that, learn more. For both settings, we noted positive attitudes towards clickers, indicating that the use of clickers makes students more positive to the course and its content, irrespective of if clickers are used for control or not.

Introduction

What is a clicker?

A clicker (also called an ARS (Audience Response System) or a CRS (Classroom Response System) is a handheld instrument that (in most cases) each student (sometimes a group of students) uses during class (see e.g. Mayer et al, 2008; Deleo et al, 2009). The instructor has a receiver attached to a computer, a computer that also has software that often operates within Microsoft PowerPoint. The teacher states a multiple choice question (often presented on a PowerPoint slide as well). The students answer with the help of the clicker, and the receiver register all the answers. In the PowerPoint presentation, the teacher thereafter presents on-the-spot information (maybe in the form of a diagram) about the answers from the students, and presents the correct answer to the students. This is not a new technique; according to e.g. Dill (2008; referring to Judson and Sawada, 2002) they were in use as early as in the 1960s (but then they were hard-wired). Nowadays they are more user-friendly, e.g. because they are using wireless technology.



Can clickers encourage student participation in large classes?

Research shows that students perform better in their learning (on a final test) if they answer adjunct questions during their studies (e.g. Andersson & Biddle, 1975, referred in Mayer et al, 2008). The best result is obtained should the questions be conceptual rather than factual or verbatim (Sagerman and Mayer, 1987), and if the students also discuss the answers aloud (Roy and Chi, 2005, referred to in Mayer et al, 2008). All these elements can be fulfilled with clickers. And clickers also leads to an increased interaction between faculty and students (Auras and Bix, 2006; Caldwell, 2008; Jones et al, 2009) which, again, is important for learning.

“Clickers can provide a means of assessment during class, improve attendance, increase interaction, create a fun atmosphere, and ad a media-enriched environment that today’s [...] students’ desire”, says Jones et al (2009, page 2) in their study of clickers in a nursing class.

Student interaction is often conceived of as important for learning. Often, students in large classes report that they feel as passive recipients of the instructor’s lecture. They do not feel that they are engaged in an interaction with the instructor. Instructors, on their side, often report that it is important to have students become engaged, so that they try harder to make sense of the material that the course consist of; that they perform better if they are motivated and engaged. So; how can we as instructors promote students interaction when the classes are large? Can clickers be a tool in this endeavor?

Theoretical framework

There are a lot of articles written about clickers nowadays (see e.g. De Gagne, 2011, for a review). We have found two types of studies about clickers; those that are focused on the learning outcome of the use of clickers, and those that are focused on the student's perception (which is the subject of this study) as well as the teacher's perception. Most of the research falls into the latter category, the perception (Mayer et al, 2009). We start with a discussion about the learning outcome, to give an idea on the problems with that evaluation, and after that we focus on student perception.

Do clickers increase learning?

Studies on the learning outcome of the use of clickers give very disparate results (Vital, 2012). One can summarize them in the following way; some of the studies shows increased learning, some of them shows no increase at all in learning (we have found no study showing a decrease in learning). Amongst many of the studies that shows increases in learning, most seems to conclude that it is not the clicker in itself that increase learning (not the technology), but the pedagogy that has to be used when clickers are used (student interaction and so on). This part of the research is quite new: E.g. Mayer et al (2009), in such a recent study, reports that they didn't find any peer-reviewed published articles that compared a clicker group to a control group on a learning test. This has changed.

Dill (2008), in a study where she compared two groups in library instruction where one group had clickers and one group not, found no gain in retention at all with the use of clickers. The same was found in a study by Patterson et al (2010) for nursing students. And in a study where clickers were used to assess oral presentations (De Grez et al, 2010), the researchers found that the learning effect was rather limited. As many others, however, they reported that the use gave very positive students' attitudes, and, also, that it was an effective way to produce feedback for presenters, assessors, and educators.

But there are also strong implications that clickers give increased learning. Buhay et al (2010), in a study concerning a library instruction course with three groups; one with individual clickers, one with group-wise clickers, and one without clickers, found that the learning increased significantly with clickers. The effect could be seen in both clicker-groups.

Mayer et al (2008), in their study of clicker use in a college-level educational psychology class (139 students) compared to a similar class that didn't use clickers, found that the clicker treatment produced a gain of around 1/3 of a grade point. They conclude that this is because the students become more engaged when clickers are used. They state that the "media do not cause learning, but other methods cause learning" (Mayer et al, 2008, page 53). Their concluding hypothesis is that it was the act of trying to answer the questions and getting immediate feedback that encouraged the students to engage in appropriate cognitive processing (paying more attention to the lectures, organizing and integrating knowledge, and developing skills to answer that type of questions).

Vital (2012), in his study where a clicker-group was compared to a traditional group, found some improvement with the help of clickers when it came to some of the conceptual units and some of the nomenclature units, but no or very little effect on the rest, including mathematical concepts. His conclusion when it comes to mathematical concepts was that it takes more time, which means that

the teacher cannot put up so many mathematical questions with clicker answers on a lecture. On the other hand, he concludes, the questions can offer the teacher insight as to where the student error is occurring should the questions be well prepared.

And Deslauriers et al (2011) found significant effects following the use of clickers and other pedagogical tools. They compared two series of lectures; one traditional lecture by an experienced highly rated instructor, and one lecture with a trained but inexperienced instructor using instruction based on research in cognitive psychology and physics education. Each class consisted of around 270 students, and the latter group had increased student attendance, higher engagement, and more than twice the learning in the section taught. One should remember that clickers were only one part of several in the latter group; it was more about changing way of instruction than the technology in itself.

The same theme goes back in the two studies reported by Dawson et al (2010). They wanted, amongst other, to see if there was a positive relation between students' clicker performance and their academic achievement, and if the student's learning strategies were changed because of the clicker feedback. When it came to performance; they could see a strong positive relation. But when it came to strategies for learning; even though the students said they had changed their learning style, the researchers couldn't see any such effect.

Jones et al (2009), as well as later Fifer (2012), discuss clickers in the light of Chickering and Gamson's (1987) best practices in education. The principles as a pedagogical basis for clickers give the following reasoning for their seven principles:

1. *Good practice encourages student-faculty contact.* Interaction with faculty has a significant influence on the student's motivation and perseverance. Clicker-use promotes this, especially if the teacher encourages discussions around the answers.
2. *Good practice encourages cooperation among students.* Learning is deeper and sticks better if it is a collaborative effort. Teachers can create teams that "play" games with clicker's questions. Also, not mentioned in their article, clickers can function as a starting point, with discussions in teams as a means to come to the correct answer.
3. *Good practice encourages active learning.* Students do not learn much just by sitting in class and listening. Clickers engage every student during class by asking for their responses to the question.
4. *Good practice gives prompt feedback.* This is because knowing what you know and what you don't know focuses learning. The clicker feedback provides a reality check, where the student can see how well prepared s/he is for the exam, and the teacher can see how well prepared the class is for this.
5. *Good practice emphasizes time on task.* Learning to use time well is a critical skill for everyone, since time plus energy equals learning. Clicker use is effective in conserving class time.
6. *Good practice communicates high expectations.* Expect more and you will get more from the students. This is not discussed in the article, but from above we can conclude that students can see the expectations from the teacher in the questions asked for clickers.

7. *Good practice respects diverse talents and ways of learning.* It is important to allow for different learning styles. Clickers add another dimension, another style, to learning. It suits some better than other students; and it will probably help some of them.

One reason why clickers tentatively should increase learning is that it makes the students forced to reason to choose an answer, and that they tend to be committed to that answer; they become emotionally involved in the learning process and therefore more attentive to the continued discussion (Beatty, 2004; DeBourgh 2008; both cited in Fifer, 2012).

To summarize this discussion: The results when evaluating clickers' effect on learning vary a lot. Our standpoint, after having read the literature in this field as above, is that the use of clickers gives pedagogical elements in a course that increase students' performance, but that this is difficult to measure.

How do students and teachers perceive clickers?

Many studies focus on how students and teachers perceive the use of clickers. Many of the studies above discuss this, and next we take a deeper grip on this aspect.

In their study, Deleo et al (2009) found that clickers gave increased engagement in their group of teachers. The teachers (that were students in an Educational Leadership and Technology program) found it very motivating, and believed that the clickers could be very useful in their own classes. The game-like nature of the clickers also made the sessions interactive and engaging. The students likes the fun atmosphere that can be created with clickers (Caldwell, 2007), and the students feel satisfied as they can see that they learn more, and learn according to the purpose of the course (Auras and Bix, 2006). Clickers can create a positive learning environment (Vital, 2012), which can increase student achievement.

In the study by Patterson et al (2010), where the researchers couldn't find any positive effect on the results, they found that the students involved thought that it was positive to be able to respond anonymously, validating an answer while providing immediate feedback, and providing an interactive and engaging environment. So; there was an increased degree of classroom engagement.

One important aspect of clickers' classes is that all students have a chance to participate in answering the questions. This means that they get a comparison. They can e.g. find out that they are not the only ones having problem with a specific part of the course (Wood 2004).

FitzPatrick et al (2011), in their survey of 293 students, found that students perceived that clickers gave them good to great gain in engaging them in active learning, increasing participation and involvement during class, maintaining their attention, applying material immediately, providing feedback about their understanding, and offering them anonymity. However, their hypothesis of increased student performance was not supported.

Also from the teacher perspective, many studies reports advantages when clickers are used. With the answers, the teacher can see the level of knowledge in the group. If s/he finds out that many students have problems with a concept, the next step can be to go deeper into that concept. On the contrary, if s/he finds out that most of the students know the concept very well, s/he can skip that part of the lecture (Caldwell, 2007).

Teachers often report that they like to use clickers. One reason for this could be the student's perceptions as reported above. Also, clickers pace or break up the content of the lecture (Caldwell, 2007; Jones et al, 2009), giving the teacher time to think about the parts of the lecture to follow. Clickers also give a mean to focus the class on discussions rather than on lecturing. Furthermore, clickers pinpoint struggling students; what are the parts of the content that the students have problems with (Vital, 2012)? With this, the teacher can interact with the students in the parts where the problems exist.

The Study

The Problem Statement

Students may or may not give their answers anonymously. Each clicker has its specific serial number. If the teacher registers what student has what clicker, it is easy to follow each student's contributions; have the student answered the questions, which can be an indication of the student's engagement and maybe also be indicative of whether the student has been absent or not? And is the answer correct, indicating that the student has knowledge in the field (an assessment of the knowledge)?

The problem that we investigate in this study is; what is the best for learning; that the student is anonymous or not when using the clicker?

Vital (2012) reports from his study, in which individual student's participation couldn't be traced from the clickers. This created a positive learning environment. The clickers were used for formative assessment. It allowed the students to monitor their learning, compare themselves with the rest of the class, and discuss the answers with other students to further understand the content.

Most of the studies that we have found seem not to have used clickers that trace each individual student. But there are exceptions, e.g. Jones et al (2009). They also report, from Auras and Bix, 2006; and Caldwell, 2007, both that students came to class more prepared when they knew that clickers would be in use and answers given on the questions would impact their grade, and that clickers used this way increased student attendance.

If the clicker usage influences control of attendance, there might be a problem where one student has more than one clicker; "helping" another student with attendance. It is of course important to have means to control for this, but this is difficult with large classes. One solution, suggested e.g. by Jones et al (2009), would be to take a manual attendance now and then and require students to keep clickers up on their desk. Also: If the clicker usage influence grading, it is of course important to let the students know the precise rules for this beforehand (Jones et al, 2009).

The aim of this study is to find out whether it is best for learning if the students are anonymous or not when using the clicker. The study is explorative, and a preparation for a more descriptive study to follow.

Empirical data

The setup for this study was two classes at the Department of Industrial Management (Indek), School of Industrial Management, KTH, in Stockholm, Sweden. The students in both courses came from different programs at KTH, studying engineering in one way or another.

The first course, called *IM* (Industrial Management) gives the students a ground knowledge in the field, with most of the classes dealing with such subjects as CVP analysis, costing, investment appraisal, management control, accounting, financial control and such; but also with shorter discussions about such topics as strategies, entrepreneurship, organization, leadership and so on. The number of students in the course was 76 and most of them are in the second or third year of studies. In the course, the students are anonymous when it comes to clicker usage.

The second course, called *MC* (Management Control) gives the students, that have already participated in the *IM* course (often one or two years earlier), deeper knowledge in the field of management control with such topics as budgetary control, costing, performance measurement, standard costs, investment appraisal, and so on. The number of students in the course was 60 and most of them are in the later part of their studies. In the course, the students get their grades partially on their participation on lectures as indicated by the use of clickers, and on their answers at clicker questions. This is clearly stated beforehand.

Procedures

Clicker questions come in many ways. In our study, we used a variety of questions: Conceptual questions, questions that asked for a definition, questions about the result of calculations, and so on. And we set up the questions in many different ways: One of the most discussed types of questions is questions that leads to peer discussions; where students teach and help each other, and together come to a conclusion (see e.g. Mazur, 1997). Studies have found that this peer discussion enhances understanding; even when none of the students in the group originally know the correct answer (Smith et al, 2009). We used that, but we also used questions that the students should answer individually.

One decision when it comes to clickers is how many questions that should be asked. Mayer et al (2009) used two to four PowerPoint slides with one question each for each of the 18 lectures. DesLauriers et al (2011) used an average of 1.5 (range 0 to 5) clicker questions per 3-hour-class. We tested different amounts; from only 2-3 per 2-hour class up to (in rare circumstances) 20-30 fast questions in a one-hour lecture.

Jones et al (2009) recommends that the questions should be short enough that they can be read and answered within 30 seconds to 1 minute. This is a recommendation from their experience with clickers. Some of our questions took longer time than that, maybe up to five minutes.

It is important that the clicker questions and the alternative answers are well-crafted in order to stimulate discussion and student learning (Vital, 2012). This takes a lot of time and requires creativity. Also, by giving some of the students an opportunity to defend their answers, the teacher can facilitate learning by correcting misconceptions (Vital, 2012). We tried to create good questions for these purposes, but realized that some of them failed: Sometimes, there was no discussion at all.

Clickers' evaluation process

We constructed our questions independent of research. This was to get a starting point without knowing that much about theory in the field, but following our experience of clickers. The questions for the courses were the following (translated from Swedish):

1. *In general terms, how do you feel about the use of clickers in this course?* [1 very positive, 2 positive, 3 neutral, 4 negative, 5 very negative]
2. *How do you feel that your learning has been affected by the use of clickers compared with if time had been used for other activities?* [1 much more learning with clickers, 2 more learning with clickers, 3 neutral, 4 less learning with clickers, 5 much less learning with clickers]
3. *What type of questions do you feel gives most value with clickers?* [1 Conceptual questions ("a company says that... what type of strategy is this?"), 2 Questions on definitions ("What is a specific cost?"), 3 Exercise questions ("What is the answer?"), 4 All three are as valuable]
4. *In this course, the teacher has waited until about 5/6 of the students with clickers have answered the question, and then counted down before closing the poll. What do you feel about the tempo that this gives?* [1 Much too high tempo, 2 Too high tempo, 3 Appropriate tempo, 4 Too slow tempo, 5 Much too slow tempo]
5. *In this course, questions that you have answered individually have been mixed with questions for which you have been encouraged to discuss with the student sitting next to you, and questions that combine these two. Which is the best?* [1 Questions where I answer individually are the best, 2 Questions where I first discuss with the student sitting next to me are the best, 3 Questions where I first answer individually and then after a discussion with the student sitting next to me are the best]
6. *In this course, there were some parts where only a few clicker questions (maybe 2-4 per hour) were used, and some parts where a large number of clicker questions (maybe 20-30 per hour) were used, and a middle form where maybe 5-10 clicker questions per hour were used. Which of them gives most?* [1 Parts with 2-4 questions per hour gives most, 2 Parts with 5-10 questions per hour gives most, 3 Parts with 20-30 questions per hour gives most]
7. *What in the use of clickers gives most, as you perceive it?* [1 The most valuable part is to discuss with the student sitting next to me, 2 The most valuable part is to be forced to give an answer, 3 The most valuable part is to follow the discussion around the result, 4 The most valuable part is to feel that you have been able to give an answer]
8. *How do you feel about the discussion around the answers given (when the teacher says what he feels is the correct answer, and when the reasons for this are dealt with)?* [1 The discussion should be given much more time, 2 The discussion should be given more time, 3 The discussion was given appropriate time, 4 The discussion should be given less time, 5 The discussion should be given much less time]
9. Different for the courses:
 - a. *IM: Some teachers use clickers to check attendance; it gives an effect on the grade for the course if the student has been on a certain amount of lectures. How do you feel about this, compared to if attendance according to clicker does not affect the grade?* [1 It is very positive for the learning, 2 It is positive for learning, 3 It doesn't affect learning, 4 it is negative for learning, 5 it is very negative for learning]

- b. MC: *To give bonus if the clicker-registration proves that you have participated on a certain amount of lectures. How do you feel about this, compared to if attendance does not affect the grade?* [Same scale as a.]

10. Different for the courses:

- a. IM: *Some teachers lets the answers on the clickers-questions be part of the examination; if a student has a large proportion of correct answers, this affect the grade in a positive way. How do you feel about this, compared to the answers does not affect the grade?* [1 It is very positive, 2 It is positive, 3 It isn't neither positive nor negative, 4 it is negative, 5 it is very negative]
- b. MC: *To let the answers on the clicker-questions be a part of the examination; if a student has a large proportion of correct answers on the questions this affects the grade in a positive way. How do you feel about this, compared with if the answers are not part of the examination?* [Same scale as a.]

In the IM course, the questions were first given as clicker questions at the end of class, on the last lecture of the course. Unfortunately, there was a mistake by the teacher and the responses disappeared. And the students had handed in their clickers. Therefore, the same questions were given to the students at the ending seminar, with the instruction that only students that had participated at least at one lecture with a clicker should fill in the answers to the questions.

In the MC course, the questions were given as clicker questions at the last lecture. This means that only students that had a clicker at that specific time answered the questions.

Results

In table 1 below, the result for the IM course can be found. The response rate is 49 %.

A Q	1	2	3	4	5	Sum
1	18 (49 %)	19 (51 %)	0	0	0	37
2	7 (19 %)	25 (68 %)	5 (13 %)	0	0	37
3	8 (22 %)	11 (30 %)	0	18 (49 %)	-	37
4	0	1 (3 %)	36 (97 %)	0	0	37
5	14 (38 %)	9 (24 %)	14 (38 %)	-	-	37
6	3 (8 %)	32 (86 %)	2 (6 %)	-	-	37
7	1 (3 %)	9 (24 %)	25 (67 %)	2 (6 %)	-	37
8	0	10 (27 %)	27 (73 %)	0	0	37
9	1 (3 %)	5 (13 %)	16 (43 %)	8 (22 %)	7 (19 %)	37
10	1 (3 %)	8 (22 %)	3 (8 %)	15 (40 %)	10 (27 %)	37

Table 1. IM-course

In the following, the most common alternative is placed first. [Question 1] All students (100 %) are positive or very positive to the use of clickers in the course. [Question 2] 87 % of the students believe that they have learnt more or much more with the help of clickers, 13 % believe that the clickers had no effect on their learning. [Question 3] 49 % of the students feel that all types of questions are as valuable, 30 % prefer questions on definitions, 22 % prefer questions on concepts, and none of them prefer exercise questions. [Question 4] 97 % of the students felt that the tempo of the clickers questions was appropriate, 3 % that it was too high. [Question 5] 38 % of the students preferred questions that were first answered individually and then discussed with a peer, 38 % preferred

questions that they answered individually and 24 % preferred questions that were first discussed with a peer. [Question 6] 86 % of the students felt that 5-10 questions per hour gave the most, 8 % 2-4 questions, and 6 % 20-30 questions. [Question 7] The most valuable part of the clickers use is the discussions around the result (67 %), to be forced to give an answer (24 %), to have the possibility to answer (6 %), and to discuss with peers (3 %). [Question 8] 73 % of the students felt that the time given for the discussion of the answers was appropriate, whilst 27 % felt that it should be given more time. [Question 9] 43 % of the students feel that the use of clickers to check attendance doesn't affect learning, 41 % that it would be negative or very negative to learning, and 16 % that it would be positive or very positive to learning. [Question 10] 67 % of the students felt that if the answers on the clickers questions would affect the grade, this would be negative or very negative, 25 % that it would be positive or very positive and 8 % were neutral to this.

In table 2 below, the result for the MC course can be found. The response rate is between 70 % and 82 % depending on question.

A Q	1	2	3	4	5	Sum
1	7 [14 %]	18 [37 %]	10 [20 %]	12 [25 %]	2 [4 %]	49
2	2 [4 %]	23 [48 %]	12 [25 %]	7 [15 %]	4 [8 %]	48
3	20 [42 %]	9 [19 %]	5 [11 %]	13 [28 %]	-	47
4	2 [4 %]	7 [15 %]	28 [62 %]	7 [15 %]	2 [4 %]	46
5	5 [11 %]	19 [42 %]	21 [47 %]	-	-	45
6	22 [50 %]	21 [48 %]	1 [2 %]	-	-	44
7	11 [26 %]	8 [19 %]	23 [55 %]	0	-	42
8	6 [14 %]	16 [38 %]	19 [44 %]	1 [2 %]	1 [2 %]	43
9	9 [19 %]	12 [26 %]	9 [19 %]	3 [6 %]	14 [30 %]	47
10	11 [24 %]	15 [32 %]	6 [13 %]	4 [8 %]	11 [23 %]	47

Table 2. MC-course

In the following, the order of the alternatives is the same as for the IM course. [Question 1] 51 % of the students are positive or very positive to the use of clickers in the course, 29 % are negative or very negative, and 20 % are neutral. [Question 2] 52 % of the students believe that they have learnt more or much more with the help of clickers, 25 % believe that the clickers had no effect on their learning, and 23 % believe that the effect was negative or very negative. [Question 3] 28 % of the students feel that all types of questions are as valuable, 19 % prefer questions on definitions, 42 % prefer questions on concepts, and 11 % of them prefer exercise questions. [Question 4] 62 % of the students felt that the tempo of the clickers questions was appropriate, 19 % that it was too high or much too high, and 19 % that it was too slow or much too slow. [Question 5] 47 % of the students preferred questions that were first answered individually and then discussed with a peer, 11 % preferred questions that they answered individually and 42 % preferred questions that were first discussed with a peer. [Question 6] 48 % of the students felt that 5-10 questions per hour gave the most, 50 % 2-4 questions per hour, and 2 % 20-30 questions per hour. [Question 7] The most valuable part of the clickers use is the discussions around the result (55 %), to be forced to give an answer (19 %), and to discuss with the student next to me (26 %). [Question 8] 44 % of the students felt that the time given for the discussion of the answers was appropriate, whilst 52 % felt that it should be given more and 4 % less time. [Question 9] 19 % of the students felt that the use of clickers to check attendance didn't affect learning, 36 % that it was negative or very negative to learning and 45 % that it was positive or very positive to learning. [Question 10] 31 % of the students felt that it was

negative or very negative that the answers on the clicker's questions affected the grade, 56 % that it was positive or very positive, and 13 % were neutral to this.

When interpreting those data, it is important to keep in mind that these are two different courses, at different levels, with different teachers and students, and so on. Therefore we cannot say much about the absolute results of the study as such. We can only see some implications on this. What we also can do, is to try to understand the differences in one question from the differences in another questions.

More of the IM students are positive to the use of clickers (100 % compared to 51 %), and believe that clickers have increased their learning (87 % compared to 52 %). This could either be an effect from the fact that the MC students are more controlled by the clickers (that their attendance are checked by them and that their grades are dependent upon them), or be an effect from the differences between the two courses. Our following studies will try to answer this type of questions by controlling for these factors.

When it comes to the two direct questions about the use of clickers, the findings can be summarized as in table 3 below.

Do attendance-check affect learning?	Positive	No	Negative
- IM	16 %	43 %	41 %
- MC	45 %	19 %	36 %
What if your answers affect your grade?	Positive	Neutral	Negative
- IM	25 %	8 %	67 %
- MC	56 %	13 %	31 %

Table 3. Questions 9 and 10 summarized

As can be seen in the table, MC students do, to a much higher degree than IM students, believe that attendance-check by clickers are positive for learning, and they are also, to a much higher degree than MC students, more positive to let the clickers answers affect their grade of the course. Our interpretation is that if never tested, control by clickers seems "scary", but that students that have experienced this can see that they can be positive.

There is a difference when it comes to preferred questions between the groups. In the IM course, 49 % of the students believe that all types of questions are valuable (compared to 28 % for MC), while the students of the MC course prefer conceptual questions (42 %, compared to 22 % for IM). Our interpretation is that this is because of the higher level of that course: In the IM course, the students focus more on learning definitions and solving exercises, while in the higher level course that MC is, the concepts, cases and such are more in focus.

There are some results that we believe could be caused by the difference when it comes to the use of clickers. MC students tend to prefer to discuss with a peer before they answer a question (47 % prefer to first answer individually, then after a discussion with a peer; 42 % to discuss with a peer directly; and only 11 % to answer individually; for IM the figures are 38 %, 24 %, and 38 % respectively). This could be an effect of the grading system: If you are not graded from your answers, it is more OK and not that scary to answer individually.

In the IM course, most students prefer to have 5-10 questions per hour (86 %, compared to 48 % in the MC course), while MC students prefer 2-4 questions per hour (50 %). We interpret it as since the MC students grades are affected by their answers, they like to have fewer questions; fewer checks.

When it came to the most valuable parts of the clickers use, we can conclude that students of both courses stated that the discussions was the most valuable part (67 % in IM course, 55 % in MC course), and that to be forced to answer was also valuable (24 % and 19 % respectively). But then there is a difference that we don't yet have any interpretation for: 26 % of the MC students and only 3 % of the IM students (1 student) believed that the discussion with another student was the most valuable part. Maybe this also could be due to the higher level of the MC course.

There are some differences that we do not believe are effects of the way the clickers are used, but that are interesting as such. In the IM course 97 % of the students said the tempo was OK, while the same figure for the MC course was only 62 %. In the IM course, 73 % of the students felt that the time for discussion was enough and 27 % that more time was needed, with the same figures for the MC course being 44 % and 52 % respectively.

Discussion and conclusions

Clearly, from a student perspective, clickers make students more satisfied with the classes, and give them the feeling that they have learnt more. This is in line with research about student satisfaction discussed earlier.

If the clickers are not used for control of the student, but only for learning the course content, students seem to be more open for different types of clicker usage: different types of questions, different amounts of questions, and so on. This is in line with Vital (2012), who reported that this creates a positive learning environment. Students might be more open to different types of learning in this environment. If they are also used for control of the student, students still tend to feel that have learnt more, maybe more indirectly from the behavior that the control forces on them. As discussed earlier (Jones et al, 2009; Auras and Bix, 2006; Caldwell, 2007), naturally, student attendance increase, and the students tend to come to class more well prepared when this control is put on them.

Students that have been controlled by clickers are more positive to this than students that have not. This result stresses the importance to communicate the advantages of control when the course starts, in order to make the students aware of this.

To summarize, when it comes to the aim of the study, we have found that the use of clickers gives an advantage for learning and student experience whether they are used for control or not.

What are the practical implications of our study? Mayer et al (2009, page 56) summarize the practical implications of their study in the following way: "If the goal is to help students learn in large college lecture classes, there is reason to consider using a personal response system to foster student-instructor interaction during class." This is also our standpoint. We have found that clickers add a lot to the experience for the students and that this is true whether they are used for control or not.

Mainly as something that makes the course and its content more interesting, but also as a way to learn more.

Further research

Our results are not as stable as they could be, since the differences could be there not only because of differences in the use of control together with clickers, but also because of many other factors (differences between students, between teachers, between subjects taught, and so on). Therefore, a study with more comparable student groups would further clarify the difference. Also, more care should be taken when choosing questions for further research: We have found many interesting questions in earlier studies that could further the knowledge in this field. We intend to study this subject more, with these improvements in our approach.

References

- Andersson, R.G. and Biddle, W.B. (1975): "On asking people questions about what they are reading". *Psychology of Learning and Motivation*, volume 9, pages 90-132.
- Auras, Rafael, and Bix, Laura (2006). "Wake up! The effectiveness of a student response system in large packaging classes". *Packaging Technology and Science*, Volume 20, pages 183-195.
- Beatty, Ian (2004). "Transforming student learning with classroom communication systems". *Educause Center for Applied Research (ECAR) Research Bulletin*, Issue 3, pages 1–13.
- Buhay, Diane; Best, Lisa A.; and McGuire, Katherine (2010): "The Effectiveness of Library Instruction: Do Student Response Systems (Clickers) Enhance Learning?," *The Canadian Journal for the Scholarship of Teaching and Learning*, volume 1, issue 1, article 5.
- Caldwell, Jane E. (2007). "Clickers in the large classroom: Current research and best-practice tips". *Life Sciences Education*, volume 6, pages 9–20.
- Chickering, Arthur W., & Gamson, Zelda F. (1987). "Seven principles for good practice in undergraduate education". *Biochemical education*, volume 17, number 3, pages 140-141.
- Dawson, Debra L.; Meadows, Ken N.; and Haffie, Tom (2010): "The Effect of Performance Feedback on Student Help-Seeking and Learning Strategy Use: Do Clickers Make a Difference?" *The Canadian Journal for the Scholarship of Teaching and Learning*, volume 1, issue 1, article 6.
- De Gagne, Jennie C. (2011): "The impact of clickers in nursing education: A review of literature". *Nurse Education Today*, volume 31, pages 34–40.
- De Grez, Luc; Valcke; and Berings (2010): "Student response system and learning oral presentation skills". *Procedia Social and Behavioral Sciences*, volume 2, pages 1786–1789.

Deleo, Patricia A.; Eichenholtz, Susan; and Sosin, Adrienne Andi (2009): "Bridging the Information Literacy Gap with Clickers". *The Journal of Academic Librarianship*, volume 35, number 5, pages 438–444.

Deslauriers, Louis; Schelew, Ellen; and Wieman, Carl (2011): "Improved Learning in a Large-Enrollment Physics Class". *Science*, volume 332, pages 862-864.

Dill, Emily: "Do clickers improve library instruction? Lock in your answers now". *The Journal of Academic Librarianship*, volume 34, number 6, pages 527–529

Fifer, Pamela (2012): "Student perception of clicker usage in nursing education". *Teaching and Learning in Nursing*, volume 7, pages 6–9.

FitzPatrick, Kathleen A.; Finn, Kevin E.; and Campisi, Jay (2011): "Effect of personal response systems on student perception and academic performance in courses in a health sciences curriculum", *Advances in Physiology Education*, number 35, pages 280-289, 2011.

Jones, Sandra; Henderson, Deborah; and Sealover, Pamela (2009): "'Clickers' in the classroom". *Teaching and Learning in Nursing*, volume 4, pages 2–5.

Judson, E., & Sawada, D. (2002). "Learning from past and present: Electronic response systems in college lecture halls". *Journal of Computers in Mathematics and Science Teaching*, volume 21, number 2, pages 167–181.

Mayer, Richard E.; Stull, Andrew; DeLeeuw, Krista; Almeroth, Kevin; Bimber, Bruce; Chun, Dorothy; Bulger, Monica; Campbell, Julie; Knight, Allan; and Zhang, Hangjin (2009): "Clickers in college classrooms: Fostering learning with questioning methods in large lecture". *Contemporary Educational Psychology*, volume 34, pages 51–57.

Mazur, Eric (1997): *Peer Instruction: A Users Manual*. Upper Saddle River, NJ: Prentice Hall.

Patterson, Barbara; Kilpatrick, Judith; and Woebkenberg, Eric (2010): "Evidence for teaching practice: The impact of clickers in a large classroom environment". *Nurse Education Today*, volume 30, pages 603–607.

Roy, M. and Chi, M.T.H. (2005): "The self-explanation effect in multimedia learning". In Mayer, R.E. (ed): *The Cambridge handbook of multimedia learning*, pages 271-286. New York: Cambridge Press.

Sagerman, N. and Mayer, R.E. (1987): "Forward transfer of different reading strategies evoked by adjunct questions in science text". *Journal of Educational Research*, volume 79, pages 189-191.

Smith, M. K.; Wood, W. B.; Adams, W. K.; Wieman, C.; Knight, J. K.; Guild, N.; and Su, T. T. (2009): "Why Peer Discussion Improves Student Performance on In-Class Concept Questions". *Science*, volume 323, pages 122-124.

Vital, Fred (2012): "Creating a Positive Learning Environment with the Use of Clickers in a High School Chemistry Classroom". *Journal of chemical education*, volume 89, pages 470-473.

Wood, William B. (2004) "Clickers: A teaching gimmick that works". *Developmental Cell*, volume 7, number 6, pages 796–798.