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Keywords
Personal response systems, Graduate Education, Health Professions education, Scholarship of teaching and learning (SoTL), Student perceptions, Higher education

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Introduction

Personal Response Systems (PRS), also known informally as "clickers," consist of small handsets used to send wireless signals from each student to a computer used to display results on an LCD projector. Responses are tallied by the computer and displayed on the same projector screen in a variety of formats. Quizzes most often consist of multiple-choice questions; these questions, along with answer options, can be constructed on any topic, at the discretion of the instructor. Instructors using PRS can track and record individual student responses and participation, and attendance can also be recorded through participation in PRS quizzes. Quizzes may be constructed as stand-alone activities or inserted into slideshow presentations.

The use of a Personal Response System began in our physical therapy curriculum three years prior to this study. Faculty members had no prior experience using this technology, but had become interested through informal communication with faculty members at a different institution. Subsequently, PRS was incorporated into several different types of courses including anatomy and kinesiology, basic and advanced clinical concepts, and clinical problem-solving. The primary investigator used PRS in most of her courses and

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received frequent student comments related to their undergraduate experience with PRS, as well as comments about PRS quizzes as they were currently being used in our curriculum. Students appeared to have valuable insights about the types of PRS questions and activities that they felt facilitated the most effective learning. This research project was designed to explore and document their opinions and preferences regarding PRS, but also to assess whether these opinions and preferences accurately represented those of the students as a whole. Student perceptions and preferences provide a valuable source of information that can help faculty members construct their PRS activities to maximize student engagement, satisfaction, and learning.

Student participation during PRS quizzes has been widely reported to be higher than during other forms of quizzing used during lectures, such as hand-raising (Corcos & Monty, 2008; Gauci, Dantas, Williams, & Kemm, 2009; Mayer et al., 2009; Shaffer & Collura, 2009; Stowell, Oldham, & Bennett, 2010; Weerts, Miller, & Altice, 2009). It has also been observed that females are less likely to participate using hand-raising as compared to their participation using PRS (Graham, Tripp, Seawright, & Joeckel, 2007). Also, student responses have generally been found to be more honest when using PRS than when using other forms of student response to questions during lectures, such as response cards. Students using response cards have been observed looking around at other student responses before committing to their own, which often seemed to follow the majority of responses made by other students.

A recent review of PRS in higher education reported that the vast majority of published research on the use of PRS in higher education is related to use in large introductory physics, biology, and psychology courses (Caldwell, 2007). Two of the most well-known scholars in the use of PRS are Eric Mazur (2001) in physics, and Bruff (2009) in several disciplines, primarily mathematics. More recent investigationsinclude other large lower-division courses such as chemistry (Donovan, 2008) and sociology (Mollborn & Hoekstra, 2010). It appears that impact assessment of PRS in smaller and/or upper-division courses has just begun (Reyerson, Mummey, & Higdon, 2011; Sevian & Robinson, 2011, 2011; Smith, Trujillo, & Su, 2011). The overall number of scholarly PRS publications has increased dramaticially in the past few years (an average of 10 ERIC higher education citations per year 2005-2008; 21 per year 2009-2011), but research in some areas of education is still lacking. Very little has been published on the use of PRS in graduate-level courses (Sevian & Robinson, 2011). Of the only 21 publications (an average of 3.5 per year) related to health professions education and the use of PRS, 17 involve the undergraduate nursing classroom, and none are in physical therapy or any other rehabilitation science.

The current investigation used a novel mixed method approach, which benefitted from both qualitative and quantitative aspects. The focus group is a standard qualitative method that, while including some facilitation for addressing general areas of inquiry, also encourages open participation and interaction. This open approach allows participants to express their opinions more openly than if they had been asked to respond to a survey constructed by someone outside of their experience, who may only be guessing at what areas respondents might want to address. The statements made by participants are more likely to reflect the actual opinions of the group that they represent, and the second phase of this particular methodology allows verification of the responses. Statements made in the focus group were converted into survey items, and the resulting survey was administered to the entire population of interest. Survey responses revealed whether statements made by the focus group actually reflect those of the larger group. Another unique aspect of the methodology used in this particular investigation was that the focus group was conducted in the online

environment, which allowed focus group members to participate anonymously, and also allowed students in remote locations to have an equal opportunity to participate.

Higher Education Student Perceptions of PRS

One of the difficulties in reviewing this literature was the lack of a universally accepted term for this technology. The terms "Personal Response System" and "Clickers" are frequently used; but there are others, such as "Student Response System," "Electronic Response System," and "Zappers." Many publications describe faculty members' experiences with and opinions of this technology. Increasing numbers are beginning to describe the results of systematic inquiry or assessment of student opinions and perceptions.

This technology has been in use since the early nineteen-seventies (MacKenzie, 1970; Bessler & Nisbet, 1971; Sandler & Bowles, 1974), although the systems have evolved dramatically since that time. Faculty members teaching in undergraduate sciences, especially physics, have written most of the PRS publications. Very few health professions are represented, and nearly all of the published PRS research involved applications in large lecture classes in which PRS was used to add an active learning component to traditional lectures. Student feedback has been sought almost exclusively through instructor-created questionnaires. While these questionnaires offer respondents the opportunity to add written comments, there has been minimal qualitative inquiry to assess other concerns that may not have been previously identified by instructors and incorporated into the instruments that they created.

In a comprehensive review article, Caldwell (2007) reviewed PRS use in large higher education classrooms. She found that students in these studies generally approved of PRS use, and that they especially liked the anonymity and immediate feedback that this technology provided. Students also reported that they appreciated being able to compare their answer to others and collaborate via discussions, and that use of PRS reinforced their learning. Caldwell recommended that faculty members "Shut up and listen to students to find out how they think, and pay particular attention to wrong answers" (p. 18) if they are interested in maximizing student learning from PRS activities in their classrooms.

Donovan (2008) described student responses to the use of PRS to administer what he referred to as ConcepTests in a chemistry class. Eric Mazur, a well-known advocate of peer instruction, including PRS, developed ConcepTests in physics (Mazur, 1997). In the Donovan study, students were shown a question to which they responded individually using their PRS handset. Peer discussion followed viewing of the responses by the entire class, and then students were asked to re-vote on the same question. Students felt that the process of voting, followed by peer instruction and then re-voting, increased their understanding. This positive assessment of the effectiveness of ConcepTests combined with PRS was validated through correlation of scores on test items related to those previously addressed in the ConcepTests. Participants were asked what they liked about PRS; they did say they enjoyed using the technology but even more of the positive comments were related to how it helped them achieve mastery over the course material. Donovan noted that a key portion of the implementation of PRS in the classroom was the discussion of the correct answer by either the instructor or a student. Even if the vast majority of the students answered correctly, those who did not get the correct answer need to be exposed to the correct answer and the reasoning process used to obtain it.

Most students have reported that PRS increases their engagement in classroom activities and that this facilitates their learning (Carnasciali, 2009; Hatch, Jensen, & Moore, 2005; Nelson, 2008; Shaffer & Collura, 2009). In one of the few investigations that included a qualitative component, in this case face-to-face interviews that followed participation in questionnaires, Gauci (2009) found that physiology students wanted more PRS questions based on concepts rather than facts, and more think-pair-share PRS activities. The most common comment made by these students during the interviews was that PRS "made me think" (p. 66). These students also preferred that PRS quizzes be non-graded. This preference was expressed by the majority of 688 undergraduate students in a separate investigation of PRS use in seven different content areas (Graham, et al., 2007).

Other positive student perceptions cited are that PRS quizzes increased the ability to focus, "broke up" lectures, and "lightens up the classroom experience" (Nelson, 2008). The same students also reported that they benefited from instant feedback and the ability for instructors to use feedback to elaborate on important concepts. Discussion was cited as an important aspect of what introductory psychology students felt made clickers successful, and these students felt it was important for faculty members to allow adequate time for this (Shaffer & Collura, 2009). Participants in the large investigation (7 departments and 688 students) conducted by Graham (2007) specifically felt that PRS was better used for empowerment rather than enforcement. They liked having the *opportunity* to participate, but resented being obligated to participate when attendance or their grade depended on it. Carnasciali, et al. (2009) conducted a large investigation of freshmen (427 students) in a variety of core classes. He reported that males enjoyed the discussion used in conjunction with PRS quizzes significantly more than females, and also that students with a Concrete/Reflective learning style liked learning from peers significantly more than students with other learning styles. Perceptions of upper division nursing students are also generally positive, and the students consistently report appreciating the instant feedback and the usefulness of the technology with test preparation (DeBourgh, 2008; Meedzan & Fisher, 2009; Revell & McCurry, 2010).

There are also negative aspects attributed to PRS. Cost and technical problems emerged as the most common student complaints (Caldwell, 2007; Donovan, 2008; Gauci et al., 2009; Graham et al., 2007; Hatch et al., 2005). Technical problems were seen as particularly troublesome when PRS activities contributed to course grades (Graham et al., 2007). The few negatives reported by students in Caldwell's review (2007) included cost, problems with the technology, and the amount of class time used. Students also disliked that the systems were used to monitor attendance, which they interpreted as forced attendance (Graham et al. 2007). Using technology just for technology's sake and anxiety over grading were viewed negatively by students, as were setup and breakdown time (Hatch et al., 2005). Also, students sometimes felt that PRS activities wasted class time (Gauci et al., 2009).

Methods

The present investigation was conducted simultaneously with three cohorts of students in a Doctor of Physical Therapy degree program. One group of students was in the first year of the three-year professional program (N = 18), one in the second year (N = 20), and one in the third year (N = 22). In the first phase of the study, focus groups were conducted separately with students selected from each of the three cohorts. Each total cohort was stratified into high, medium, or low academic performance groups based on overall grades. All students in this curriculum are required to achieve at least 80% on each major

examination and each overall course grade, so all stratification occurred between the 80-100% levels. This stratification was conducted and agreed upon by consensus of the investigators. After stratification, two names were randomly selected from each group. In this way, a focus group was created for each cohort made up of two members from each of the high, medium and low achievement strata. Students were invited to participate by e-mail from the primary investigator, who uses PRS regularly. Potential participants were told that a different faculty member (the secondary investigator) would facilitate the focus group and that their participation would be anonymous. If a selected student declined to participate, the selection process was repeated from the same stratum until a six-member focus group was formed for each cohort.

The two investigators created a list of guiding questions (see Appendix) based on the experiences of the primary investigator using PRS in physical therapy classes, and on informal observations and student comments made during these classes. Focus groups were conducted online using synchronous chat within our course management system. Three chat rooms were created, one for each cohort's focus group. The second investigator, who did not use PRS, facilitated the focus groups and was not involved in participant selection. Each student who agreed to participate was given electronic permission to enter the chat room by the facilitator. When students logged in, they created an alias that was not revealed to either the primary investigator or the focus group facilitator. The facilitator and participants could only identify each other through their self-selected aliases. Participants were asked to allot one to two hours for each of these chats, but the facilitator allowed each group to converse as long as desired. All participants knew that the focus group topic was their perceptions of PRS, and they were given open opportunities to voice their opinions. The facilitator used the guiding questions if groups did not discuss these areas spontaneously.

Each focus group lasted 60-70 minutes. Technical difficulties prevented entry into the chat room by some participants, and others who had agreed to participate did not attempt to log in. Since the identities of all participants were blinded, the investigators were unable to determine who had or had not participated in each focus group. The two investigators analyzed printed transcripts individually to identify common themes and comments, then consolidated the lists into a mutually acceptable list. The resulting list of themes and comments was converted into a list of statements, which was entered into a five-option Likert-type online survey (http://www.pt.armstrong.edu/mincer/SurveyPTstudentclickeropinions.pdf).

All students from the three cohorts (N = 60) were invited by e-mail to respond to the survey anonymously. Each respondent had the opportunity to add comments to each question and at the end of the survey. Reminders were sent to all students while the survey was open. The Institutional Review Board of Armstrong Atlantic State University approved this investigation, and student participation was voluntary and anonymous.

In essence, this methodology allowed focus group participants to create the survey to which each member of the population (including focus group participants) had the opportunity to respond. General agreement or lack of agreement between the survey respondents and the focus group participants were thus revealed. Survey results provided the researchers with a more accurate picture of the perceptions of the entire population, as opposed to only those of the small subset that participated in the focus groups.

Results

Numbers of focus group participants and survey respondents can be seen in Figure 1. An overall response rate of 72% was obtained on the survey. Response rates were similar for each class: 72%, 80%, and 64% for first, second, and third year students, respectively. First year students comprised 30% of the total number of respondents, while second and third year students comprised 37% and 33%, respectively, of the total.

The themes identified in the focus groups, in order of numbers of comments from most to least, were: effectiveness, technological problems, question types, graded versus ungraded quizzes, and cost. The following chat transcript excerpts briefly illustrate each of these themes. Quotes are reproduced exactly as each student typed them in during the chat room, including informal abbreviations, misspellings and other errors, because these more authentically capture the 'voice' of each participant.

Effectiveness: Students were overwhelmingly positive about how PRS or "clicker" quizzes helped them learn and made many comments about which aspects they thought were most effective. One wrote that he or she thought PRS was beneficial, "…because it really makes you think it through alone and see if you know an answer. Often times when a question is just asked to the whole class someone elses answer might make sense when they say it but I may not know if I would have been able to come up with it on my own. I think i learn the material well after I have to think on my own first and then it's followed up with a discussion." Another student also appreciated the usefulness of each student being asked to answer questions in advance of revealing the correct answer and the rationale: "helps solidify the info when you have to come up with an answer on your own before the discussion begins." One added that because all students were asked to answer each question, "It gives the quiet people a chance to answer questions which are normally answered by the same crowd of people." Many commented about how important they felt the follow-up explanations and discussions were: "i like how they are used now to facilitate discuss and make us think," and, "the discussions were almost always helpful, and clarified things for most everyone." Several participants felt that they achieved deeper and higher quality learning through PRS quizzes: "I think they help to teach logical thinking," "when we are done with the clicker quiz, I feel like I actually understand the logic behind the answers so that helps me answer questions that are about the same type of logic," "the practice questions give a chance to think critically about subject matter," and, "I think we're gaining useful deductive reasoning skills with the discussion quizzes." Several appreciated that quizzes gave them an opportunity to apply information, including case-based questions: "I like them for practice questions because it helps us to start applying some of the information," and, "good way to go over many topics/cases." The clickers also "allowed an anonymous way to assess your own knowledge of the subject matter;" and while online quizzes through course management software also provide the ability to self-assess, "there wasn't the instant feedback with the [online] quizzes" to which another student added "or if you were confused." This study was not designed to make direct comparisons to online quizzes, but nearly all participants preferred in-class PRS with explanation and discussion to online quizzes.

Technological: Many comments were related to the technical problems participants had observed during their undergraduate courses, but several felt that these problems were related to the less advanced equipment that was being used at that time. The comments about their current experience with PRS mostly related to more random, small scale (but still important) technical problems, such as device pairing issues, ("sometimes it doesn't

work and you can't connect,") intermittent system setup problems, or instructors that appeared to have difficulty operating or troubleshooting the system. The last point was illustrated when a student wrote that the technical problems were "not normally a malfunction of the clickers," and clarified that he or she was referring to user error on the part of the professor. The other comments concerning technical problems clustered into two themes: the fairness of grading students on performance or attendance when technical malfunctions cloud the results, and the loss of valuable classroom time due to technical problems. One of the participants gave the following advice to instructors: "make sure you know how to use the system to avoid errors costing quality classroom time."

Problems: Students did not spontaneously express many negative aspects of PRS but were asked to describe the biggest disadvantages. The bulk of these replies related to cost, which is discussed as a separate theme below. The next largest area of concern was the amount of class time that quizzes consumed: "some 'quizes' would end up taking half the class time" (in this curriculum, this means a quiz took more than an hour). When asked whether they thought the quizzes were a good use of class time, respondents agreed that it depended on the nature of the quiz. For example, one responded wrote that it "depends on if the material is discussed afterwards or not." This echoes the large number of responses related to the perceived effectiveness of the follow-up explanations and discussions and that the benefit of the discussion justified the class time invested. One felt that excessively lengthy quizzes "become to tedious," and another recommended that instructors should "try not to have the whole session take more than 30-45 mins" (class sessions in this curriculum last 2-4 hours each). Another concern reported by a couple of respondents was the anxiety that an in-class quiz can provoke: "I don't particulary like them as quizzes in class because if you are one of the last couple to answer people start rushing you and it tends to be a distraction." This concern emerged as a separate issue from the anxiety produced if the quizzes were graded, and was more related to being one of the slowest respondents in class often requiring everyone else to wait for them to finish. One final concern related to the LCD projector as the medium for display: "I don't think they are good for anatomy pictures on the projector because of the picture quality." Another respondent said the same thing about questions based on imaging studies (such as radiographs, for example) that were embedded in the quiz questions; the images were not clear enough to interpret accurately.

Question types: The students distinguished between types of questions used with PRS. One wrote that he or she liked "questions that were more clinically applicable . . . that presented some sort of case study, and asked for use of clinical reasoning to determine the correct answer, rather than questions that just asked for simple definitions or simple answers along those lines." Another wrote that he or she would like professors to write "quality questions that cover the material the you feel is most important and will facilitate excellent discussion for students." Again, the discussion phase emerged as important to students. One of the benefits of PRS is in preparing students for examinations. The participants stated that PRS questions were "more helpful when they were the same calibur as test questions." The structure of the questions also mattered for their performance in class: "long answer choices would take longer to read," and, "questions w/ LONG answers as choices are sometimes confusing." As with the earlier report of the lack of clarity in projected radiographic images, the lengthy response options were reported as problematic. Lengthy question stems and/or response options may not fit on the screen and be viewed in their entirety, limiting the students' ability to see the problem set as a whole. Graded versus ungraded: These students overwhelmingly preferred that PRS be used without grades attached. This seemed to relate more to the anxiety that grading provoked and that concern over grades shifted the emphasis away from real learning: "I like the use of clickers as a

teaching device, but no so much for graded quizzes or tests." "I like using them as a non-graded exercise that then prompts discussion." "If there is to much emphasis on grades it detracts away from the point of a quick self-assessment." "I think in the beginning when ppl thought they would be graded more people were too worried about their grade and less about understanding concepts." Another participant wrote that graded quizzes were "less beneficial" because "they became stressful and less of a learning environment." "I learn better when I'm not under pressure to make a certain grade."

Cost: The students were required to buy the PRS handsets and then pay a registration fee for each semester of use. While the students viewed PRS as an effective learning tool, they became frustrated when required to register for a semester in which the instructor rarely used the system: "if I'm paying for them i want to use them. that was one of my biggest complaints." Another wrote, "if you are going to use them, use them…don't have us pay $20 to activate them and use them 3 times." "The biggest disadvantage is the cost." Students didn't specify how much use would justify the cost, but did suggest that a frequency of perhaps once a week would be a justifiable balance of class time necessary for PRS use.

The survey consisted of 34 questions constructed from these focus group transcripts. Some of the questions related to the students' varied undergraduate experiences, but the majority related to their perceptions of PRS as used in the graduate physical therapy curriculum. The results described here are their perceptions and preferences related to the use of PRS during their graduate physical therapy instruction. "Agree" and "Strongly Agree" responses were collapsed into a single response category, which was compared to a collapsed "Disagree" and "Strongly Disagree" category.

The survey responses paralleled the themes and opinions expressed in the focus groups. On all items, most survey respondents agreed with the statements distilled from the focus group transcripts; but on the items in Figure 2, respondents expressed particularly strong agreement.

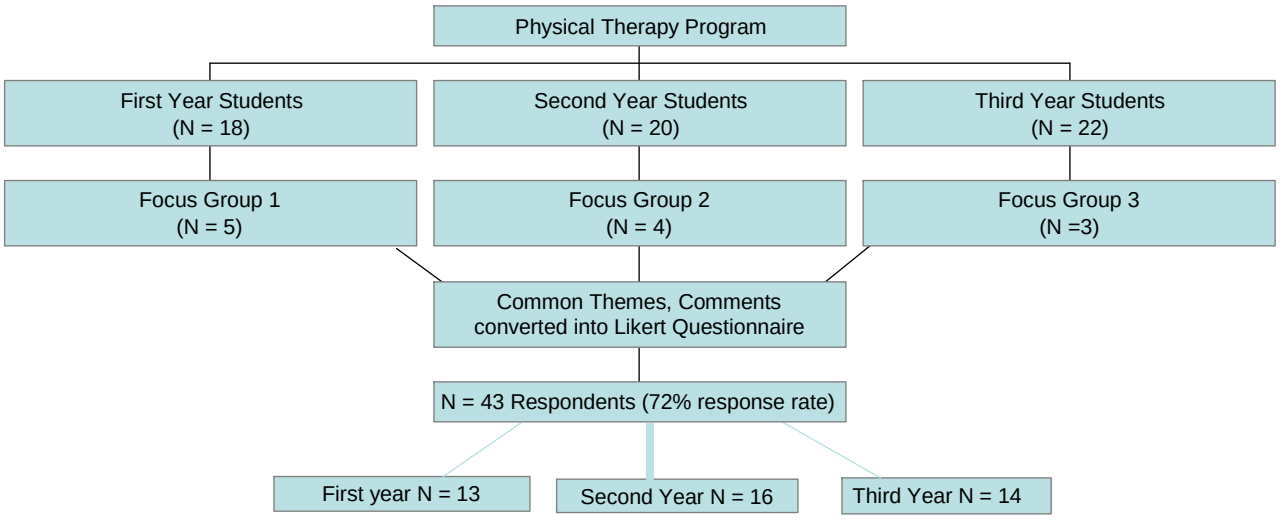

Figure 1. Graphic representation of study procedures

These are the items in which at least 80% of respondents agreed, in order of most to least agreement. The 'disagree' responses are included to demonstrate that not only did the vast majority of students agree, but also that an extremely small proportion of students disagreed with any of these statements.

Summary of Survey Statement	Agree %	Disagree %
Like having the Qs & As available after the quiz for review	100	0
Frustrating to buy and only use 2-3 times	95	0
Good way to practice applying information	95	5
Useful for facilitating discussion & explanation	93	2
Help me with exam prep if questions are similar	93	0
Good way to get immediate feedback	91	<1
Useful for reinforcing important material	91	< 1
Good way for instructor to assess a group's overall understanding	91	<1
Good way to self-assess	88	5
Good way to see what an instructor thinks is important	88	5
Can promote development of critical thinking and problem solving	86	5
Usually a good use of class time	84	<1
Like because I can get feedback without being embarrassed	84	5
I prefer ungraded quizzes to graded ones	81	0

Figure 2. 'Agree' and 'Strongly Agree' responses were collapsed into a single 'Agree' category. The same procedure was used to create a collapsed 'Disagree' category.

Discussion

Most of the published descriptions and research on PRS involved large class sections in which the intent was to increase student engagement during lectures. Most professors would agree that engaging students is particularly difficult in these very large sections, but would perhaps question whether there is a need for PRS in classes that contain fewer students. Each of the physical therapy classes in which this investigation was conducted contained only 22 or fewer students, and these students agreed with the studies of students in large classes that PRS is useful. The physical therapy students particularly appreciated that PRS facilitated discussion and explanation, enabling them to achieve a deeper and stronger understanding of important material. These results also support the very limited results of other investigators in graduate education, which suggested that even graduate students in smaller classes felt that the technology was beneficial, especially because they could self-assess their understanding without the risk of being embarrassed in front of peers or instructors and that it helped them see which concepts an instructor thinks are important. The students in the current study felt that PRS questions also gave them an opportunity to practice applying concepts and to develop critical thinking and problem

solving skills. This may be related to the nature of a health professions curriculum in which clinical application of information is emphasized and in which critical thinking and problem solving skills are stressed, but this is an important finding. Teaching students how to apply learned information in novel situations is a critical component of physical therapy education. Each patient encountered in the clinical environment presents the student with a new combination of signs and symptoms that must be evaluated and integrated into a diagnosis, prognosis, and plan of care. It is important that students are given the opportunity to practice making sense of findings and rendering an appropriate judgment about action that is required. A few of the focus group comments suggested that the degree of application and problem solving that was required depended on the construction of PRS questions, which they reported differed between instructors. As with written examinations, instructors may approach quiz construction differently. Question type may also be expected to vary somewhat depending on the content being taught. Anatomy instruction, for example, typically involves more recall of names and locations of structures with little evaluation required, while patient examination necessitates *continuous* evaluation and synthesis of information as it is received.

These student respondents observed that the type of questions used and the format of the quiz activities significantly affected how useful PRS was for helping them learn. Quiz questions were only helpful in preparing for exams, the students wrote, if they were similar to the type of questions that would be seen on the exams. They recognized that there were limitations to the multiple choice format and that not every exam question was expected to be multiple choice, but apparently also recognized a difference among various types of multiple choice questions. These graduate students were able to discern the difference and the relative usefulness of recall questions versus application questions, for example. Also, several focus group participants commented on the importance attached to the discussion of the questions and answers that followed each item on a quiz. Students felt that regardless of whether they answered a question correctly, the discussion helped them analyze and clarify the reasoning behind why each item was or was not the best choice, and recognized that this was the time in which a great deal of their learning occurred.

Students largely preferred that PRS quizzes be ungraded. Focus group comments suggested that ungraded quizzes allowed students to focus on the discussions that followed questions with less anxiety about the total grade. They expressed that they learned a great deal from the quizzes even when their grades were very low, and by not counting the quiz grades, they could attend more to the learning. Because they felt that the quizzes provided good test preparation, these students also strongly preferred to have the quizzes provided to them after class so that they could use them to study. When the quizzes were not going to be provided to them, students busily tried to type questions, answers, and explanations during the quizzes; they felt that this also detracted from their ability to focus on the important discussions that occurred during quizzes.

Students in this program were required to buy their response pads and then pay a fee to register them each semester. The largest drawback expressed by these students was related to this expense, but they qualified their response. They only felt that the expense was not justified if the professor did not use PRS regularly enough in class. Most of these students felt that using PRS quizzes once weekly justified the cost of the response pads.

The other concern expressed by some students was the feeling of having to rush to answer PRS questions. Some said that they felt they did not have as much time as needed for thoughtful consideration of the answer choices because their classmates were waiting on

them, and they wanted to hurry so others would not have to wait. Some of these students said they preferred online quizzes to PRS quizzes for that specific reason. Students in other published investigations have not expressed this concern, but this apparent discrepancy may be related to research methodology more than to a true difference. Most published research used questionnaires that were constructed by faculty who were trying to answer specific concerns of the investigating faculty member, or that the faculty member assumed would be important to students. Investigators may not have recognized that time pressure would be of concern to some students, so it was not even offered as a survey item. In other words, students in previous investigations may in fact have also felt too rushed with in-class PRS quizzes but were never asked about this particular concern.

The methodology used in the current study was unique and had several advantages in being able to virtually hear and explore the student voice. First, the focus group was conducted in a way that allowed anonymity between the facilitator and student, as well as between students. Interaction occurred online, and students signed into the focus group using a pseudonym. Students knew that the focus group facilitator was not one of the professors who used clickers and that their comments would only be communicated to other professors under their pseudonyms; there was no need to fear retribution related to negative comments. Secondly, with multiple students in each group, participants built on the comments made by other participants, supplementing, clarifying or extending the statements as needed. Because of the discussion-based format, student opinions were expressed in each student's own language. Finally, and most importantly, the entire group of current physical therapy students was given the opportunity to respond to the statements made by the sample of students in the focus groups. In this way, researchers could assess whether opinions of the focus group were representative of the whole group. This mixed method approach thus allowed exploration and interaction which provided the depth and texture of qualitative research, and validation by a larger sample which provided more quantitative insight into the larger group's opinions. This combined methodology effectively amplified the student voice.

Previous investigations have identified technical problems as a frequent student concern. The students in this investigation agreed that technical problems sometimes wasted class time, but based on the proportion of students who agreed to this statement (60.5%), further examination was warranted. Some of the focus group comments suggested that at least some of the technical problems appeared to have been related to the technical expertise of the professor, in other words user error, rather than inherent system hardware or software problems. Previous investigations have also found that many students resent having PRS used to monitor attendance or feeling like they are being forced to attend class because PRS is being used for graded quizzes. Students in the current investigation did not mention these concerns, presumably since this is a small, graduate professional curriculum with consistent student attendance that is not affected by PRS use.

Many physical therapy practitioners believe that the initial process of interviewing a patient in detail about the nature of his or her problem, what the patient believes caused the problem, and the effects of various positions and activities on that problem is the most important part of the first patient visit, even more important that the information obtained when the therapist performs physical tests and measurements. "If you ask the right questions and listen to the answers, the patient will tell you what is wrong," the saying goes. Perhaps the same is true of students. If we ask the right questions they will tell us what helps them learn. Without specific instruction or metacognitive activities, these graduate health professions student participants were able to differentiate between types of

questions, usefulness of the various types of questions for various purposes, and specific ways in which their learning was or was not augmented. They also recognized when technology was being used because the tool was available rather than as an intentional tool to enhance student understanding, as well as when user error interfered with the potential of the technology. They were even able to comment on and make specific recommendations related to the cost-benefit ratio of class time spent on quizzes versus the learning outcome achieved. College students have valuable experience and perspectives, and their voice can and should be incorporated into efforts to improve the quality of teaching and learning, including effective use of personal response systems.

Recommendations for Practice

The results of this inquiry have been very useful for understanding student perceptions of PRS, particularly related to aspects of use that they felt positively impacted their learning. These results echoed the positive student perceptions expressed in previous studies, but the mixed methodology added depth and variety to the types of concerns that have been addressed in the past. These results also emphasize the specific value that graduate physical therapy students perceive; this should stimulate other physical therapy faculty members, and faculty members in other graduate or health professions disciplines, to investigate the feasibility of use in their own curricula.

PRS use is becoming more and more widespread in higher education, which is resulting in more and more students being required to invest in PRS response pads. An internet search in early 2012 revealed that many campuses have only recently begun adopting a campus standard that would dictate which specific response system should be used by all individual professors on that campus. Adoption of a campus standard has multiple benefits, including minimizing student expense. Without a campus standard, different professors adopt and require the use of different brands of PRS. This means that in many cases individual students must buy multiple brands of clickers since the response pads are not interchangeable from company to company. Adopting a campus standard also benefits faculty members since they can more easily share the benefits of experience with one specific system and grow the expertise of the community more efficiently. Technology support services could also be streamlined with a campus-wide PRS standard.

PRS and other questioning methods foster learning by requiring that learners actively process information as they are attempting to solve the problem. This is termed generative learning (Mayer et al., 2009; Nelson, 2008). PRS also enhances the classroom experience through active learning, providing feedback, and increasing student attention; and all of these characteristics help increase student motivation (Nelson, 2008). Learning can be enhanced even further when PRS is used in conjunction with other pedagogical approaches. Corcose and Monty (2008) recommend "pairing clickers in a meaningful way with other pedagogical techniques such as peer discussion and peer teaching…as opposed to simply plugging them into existing course plans haphazardly" (p. 57). There are a number of descriptions in the higher education literature of ways that PRS can be used to support a variety of good pedagogical approaches to learning. Many professors have found that PRS facilitates other methods of obtaining student engagement and interaction. PRS also enables these professors to quickly and easily assess the effects of these approaches.

Recommendations for Further Research

The use of PRS in higher education is increasing and spreading through multiple disciplines, but published investigations into effectiveness and student perceptions of PRS have largely focused on undergraduate students in large science and psychology classes. Very little research has been conducted in graduate education. Very little research is available in the health professions, and what has been published is nearly exclusively in nursing. This investigation represents an attempt to address the lack of published research in both of these important areas.

Few studies in the published PRS literature have examined student factors that might be related to preferences or effectiveness. One may wonder, for example, whether students of color have different preferences and opinions than white students, or whether non-native English speakers have different preferences than native English-speakers. More studies are needed to see whether meaningful differences exist between male and female preferences related to PRS. Nothing in our study suggests that this is the case, but our population was 82% female, 95% white, and 100% native English speakers, which was

too homogenous for meaningful analysis. In larger, more diverse populations, this approach would perhaps be useful for attempting to add more depth to our understanding of student preferences and to be sure that learning through the use of this technology is being optimized for all students.

The methodology used in this study is one that combines the considerable advantages of qualitative inquiry with concise representations of trends provided through descriptive statistics, and could be used in a wide variety of scholarship of teaching and learning projects. By utilizing online technologies, additional advantages were realized. Focus group participants were able to participate anonymously, which may have increased their willingness and honesty in responding to the facilitator and in expressing negative opinions or disagreement. Neither focus group participants nor survey respondents had to be in physical proximity. In fact, some of the focus group participants in this study were residing temporarily in other states for clinical training. The online chat feature of the course management software maintains a written record of all communication during a focus group conducted in a chat room, and so the tedious and potentially inaccurate transcription of audio recordings was avoided. Also, the printed transcript made it easy to link the participants with their comments; this is sometimes difficult with audio recordings of group discussion.

The online focus group makes it impossible for the facilitator or other participants to read the body language and voice quality characteristics that allow for additional interpretation of subtle shades of meaning that are often easier to recognize in a face-to-face focus group. Also, participation in the online conversation may be impeded by the inability to read or type quickly; it can be difficult to follow a conversation in a synchronous chat since, in essence, the technology allows many people to 'speak' at the same time. For this same reason, it may be easier for a dominant participant to be over-represented in the online environment as there is no need to wait while others are speaking, though the reverse is also true: students who may be hesitant to speak in person may feel more comfortable participating in a written conversation.

Today's students expect to be engaged and to use technology to enhance their learning (Lindbeck & Fodrey, 2010). PRS is one option for increasing student learning, engagement, and attention, and can be a useful way of promoting application of knowledge in various disciplines, as well as problem solving and critical thinking. The results of this study further inform faculty members' understanding of student opinions, perceptions, and suggestions related to effective PRS use, which provides another source of information that can be used for revising or adopting sound pedagogical approaches to the use of PRS in the higher education classroom.

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Appendix.

Guiding questions for student focus groups

Thank you for participating in this project. We are genuinely interested in your thoughts regarding the "clickers". Your responses are anonymous – we are interested in both positive

and negative opinions. Please feel free to give us your honest and thoughtful feedback in order to better understand the 'student-side' of clicker use.

Their history with clickers before PT school

1. Good use of class time?
2. Biggest complaint about them?
3. Biggest advantage of them?

Their use in the PT program

4. Good use of class time?
5. How do they relate to your performance on or preparation for other activities, such as exams?
6. Compare clickers to Vista quizzes (perhaps including whether their preparation is any different)
7. Would you like to see more (or less) use of clicker quizzes in classes (this could mean more frequent use in any one class or could mean used in additional classes)
8. Biggest complaints or disadvantages of using them
9. Biggest advantage of using clickers
10. Do clickers benefit some types of students more than others?
11. **Do some types of questions work better than others (and <u>better in what way?</u>)
12. How does the nature of clicker quizzes change when the grades are 'counted' or not?
13. Do you know of other ways that clickers have been used in other classes before PT school that would be useful in your PT classes? Please describe

Other comments?

Thank you again for your time