
Comparison of Different Commercial Wireless Keypad Systems

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Wireless keypad systems have been in limited use for the past 10 years in the classroom.^{1,2} Such systems can be used to quiz students in real time during the class, thus engaging students more directly in the lecture.³ Nonetheless, until recently widespread use of such keypad systems has been limited for several reasons. First, the original systems were relatively expensive but perhaps more important was the reluctance on the part of faculty to change the existing passive lecture format.^{4,5} However, problems associated with large lecture classes⁶ and the validation of the concept of “interactive engagement” from the high-statistics study of Hake⁷ has changed the opinions of many. In addition the desirability of peer learning,⁸ which is enhanced with a response system, has also been accepted. At the present time a number of commercial systems are available. The purpose of this paper is to present a comparison and summary of what is commercially available⁹ and a reminder that keypads are a dramatically effective teaching and learning tool.

Basic Types of Wireless Keypad Systems

A keypad lecture equips all of the students with a small, handheld electronic device that can communicate with a receiver/computer positioned at the front of the lecture room. The systems differ according to the type of wireless system involved, RF (radio-frequency) or IR (infrared), and whether the system, keypad and receiver, is one way or two way. In a two-way keypad system the keypad and receiver both

transmit and receive, whereas the components in a one-way system are limited to usually only transmitting or receiving. There is an additional category of nonkeypad wireless systems¹⁰⁻¹¹ that are all one way. One of these systems employs flashcards.¹⁰ These systems are very inexpensive and crude, albeit useful, and are not discussed further here. Figure 1 is a photograph of keypads from three commercial systems. The exact details of the signal processing for each system varies and will not be discussed except in cases where the hardware imposes limitations on the user.

Portability

Keypads are usually stored in numbered bins. At the beginning of class, each student exchanges an ID card for his or her numbered keypad. In principle these wireless systems are all portable and can be hand carried from one classroom to the other. The portability is limited if the number of keypads is larger than about 50, in which case carts are necessary to move the components. For large auditoriums, additional receivers may be needed in the room to handle either the large number of keypads or to overcome the limited range of the keypad signals or both.

Hardware Performance Characteristics

The listing in Table I compares some of the hardware properties of the principal existing commercial systems.¹² Many of the data were obtained from the manufacturers’ websites, but in a few cases data were obtained from either the manufacturer or an actual



Fig. 1. Photograph of wireless keypads (from left), PRS keypad, CPS keypad, and Fleetwood keypad. The length of the pen is ~5.5 in/14 cm.

user. Prospective purchasers are encouraged to contact manufacturers or their representatives for formal specifications, additional details, and current pricing.

Software Features

Each wireless keypad system requires its own proprietary software. In the case of the PRS (Personal Response System)¹⁴ and the CPS (Classroom Performance System)¹³ systems, the software is provided free with purchase of the system. However, a purchaser would need to be informed of the licensing restrictions, upgrade features, etc. In the case of the Fleetwood¹⁵ system there are a host of commercial software packages available from vendors other than Fleetwood ranging in cost from \$500–\$1500.¹⁶ These same vendors market the Fleetwood system under their own names. Most keypad software comes with the ability to tabulate student scores and format them in a form exportable to Excel. It is also useful for some lecturers to be able to weave the keypad questions into PowerPoint. This feature is available for the above systems but sometimes at an additional cost. In general, most software packages are written for the PC, but Macintosh versions are also available for the CPS and PRS systems. Some PC versions can be made to run on Macintosh computers with a PC emulator.¹⁷

Applications of Wireless Keypad Systems and Limitations

Wireless keypad systems have many applications in the lecture room. The keypad questions are by nature

Table I.

	CPS ¹³	PRS ¹⁴	Fleetwood ¹⁵
Type of system	one way	one way	two way
Radiation	IR	IR	RF
Range	~30–50 ft (clear path)	~30–40 ft (clear path)	~100–200 ft ^a
Cost of receiver	\$250	\$200	\$1200
Cost of keypad	~\$60 ^b	~\$50	~\$225
Battery life	0.5–1 yr	1 yr	>3 yr

^awith obstructions

^bbookstore arrangements available

short answer (0–10 choices), but it is possible to even structure multiple-choice questions so that they simulate an essay question.¹⁸ The keypad questions can be of a wide variety, and the questions can accommodate a broad range of instructional philosophies and goals. They allow an instructor to determine the following:

- Is the student present in class?
- Have the students read the text before class?
- Are the students paying attention?
- Do the students remember important facts?
- Are the students thinking?
- Do the students recognize and have a grasp of concepts?
- Can the student work in a group (peer learning)?
- Can the students do numerical exercises?
- What do the students say about the pace and the interest of the lecture?

All the existing keypad systems can be used to record and store attendance information. In addition, all the systems can be used to grade and score the students' responses to the above types of questions. The alternative of not grading the answers to questions posed may reduce a student's desire to prepare, participate, and respond. So the grading and recording of keypad scores is arguably an essential element in keypad engagement. The weight attached to the keypad scores can vary from a negligible amount to a substantial portion (0–25%) of the term grade. During a typ-

ical semester, some 300 responses may be recorded for a given student.

Well-chosen multiple-choice questions that are embedded in the learning process have a huge advantage over the “high stakes” testing that currently plagues our high schools. The technology here offers the possibility of infiltrating classes with statewide derived questions; the source would be invisible to the student.

There is a limitation to using some commercial systems in that only two-way systems can be used as a serious grading tool. The reason for this is that in a two-way system there is a reply signal sent to the student keypad confirming that the original signal has been received. In a one-way system the confirmation process requires the student to receive visual signals, namely seeing his/her keypad number appear on the screen or recognizing a color change on the screen of his/her keypad number. This produces complications when the number of keypads is large or the student’s view is obstructed. The critical factor here is that, when keypad scores count for a substantial portion of the term grade (15–25%), the student must be confident that the system is perfectly reliable. That requires a process with a very high standard of reliability together with the student’s *perception* of this extreme reliability. Such a standard is difficult to attain with a one-way system due to its built-in limitations. These comments reflect our experience with students at Illinois Institute of Technology, where keypads have been used in the serious grading mode for more than six years.^{1,2} We have found that students are as perpetually concerned with the reliability of their keypad grades as they are concerned with quiz or examination grades.

Keypad Responses in Anonymous Mode

It is valuable to use keypads in an anonymous mode.¹⁹ In some systems an anonymous response mode is built into the software. In other systems this can be accomplished by having the students temporarily trade keypads. In this anonymous mode one can get reliable information while at the same time retaining the student’s privacy. For example, it is useful for an instructor to find out how well a topic has been understood. For this reason he/she might ask: How would you evaluate your understanding of the topic just presented?

Score	7–10	—	needs no further clarification
Score	5–7	—	a few points need clarification
Score	3–5	—	many points need clarification
Score	1–3	—	can’t even ask a question because I understand so little

Additionally, presenting questions in the anonymous mode can serve as a useful tool in acquiring data for research in physics education (PER).²⁰ This would be a new technique; research in education typically has used personal interviews to acquire data. Thus much prior education research has required large manpower efforts and the associated problems of privacy and reliability.

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12. In press we find a new similar IR system; <http://www.h-itt.com>
13. PRS is manufactured by Avantec and distributed by EduCue, 351 Alplaus Ave., Alplaus, NY 12008; <http://www.educue.com>.
14. CPS is manufactured by eInstruction Corp., 308 N. Carroll Blvd., Denton, TX 76201; <http://www.einstruction.com>. It is also available from Better Education Inc.; <http://www.bedu.com>
15. Fleetwood Group, P.O. Box 1259, Holland, MI 49422; <http://www.repliesystems.com>. Other companies market similar (RF) keypad systems with a variety of different software packages.
16. The Fleetwood Group can provide details of available software compatible with their product.
17. "Virtual PC" is a PC emulator for the Macintosh (<http://www.connectix.com>). There are other emulators available.
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20. This is an area of increasing interest. Research in physics education is a committee of the AAPT that sponsors sessions at AAPT meetings. Publications in this area appear in a supplement to the *American Journal of Physics* and elsewhere.

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