# RESEARCH BASED TEACHING AND USE OF CLICKERS IN CLASSROOM: A CASE STUDY

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## ABSTRACT

**Purpose:** Researchers have found that there is a regular decline in the number of students in science in general and physics in particular. They recommend that there is a need to transform both content as well as traditional teaching-learning technique. The noticeable learning gaps among students studying in BSc third year motivated the authors to look out for alternative innovative methods of teaching.

**Design/Methodology/Approach:** In this paper, the Clickers technology (electronic audience response systems) has been used after blending with research based teaching strategies like *peer instruction*, for teaching solid state physics course for identifying the prevailing misconceptions/learning gaps among students studying in BSc third year.

**Findings:** It has been observed that the use of clickers has promoted the active learning, engaged students more than traditional class room environment and also helped them to enhance their learning performance.

**Originality/Value:** This paper assumes importance as a lot of research has been done in Physics Education Research (PER) in the West. However, there is hardly any research done in India at undergraduate level in this field especially in solid state physics.

***Keywords:*** clickers; peer instruction; active learning.

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## INTRODUCTION

Research in the field of Physics Education Research (PER) has revealed that there is a decline in the number of students opting for science in general, and physics in particular (Seymour and Nancy, 1998). Researchers are strongly recommending the fact that there is a strong need to transform both content as well as traditional teaching-learning techniques (Hake, 1998a, b). Moreover learners do not enter the class room as a blank slate, but they have some pre beliefs in their minds known as misconceptions or alternative conceptions (Crouch and Mazur, 2001). These misconceptions create conflicts in the minds of the learners, interfere with their effective learning and therefore, considerable efforts are required by the learners to change these misconceptions (Awang, 2006). Another thing is that the conceptual learning of learners is also influenced by their learning styles and the knowledge of learning styles can provide some important insights into their learning of the subject. Felder Richard has mentioned that sometimes learners favour a particular learning style and if teaching style and learning styles do not match, then these learners face difficulties in learning (Felder and Silverman, 1987).

To identify the individual learning style, researchers have developed different learning styles models, and Felder–Silverman Learning Style Model is one of them (Felder and Silverman, 1988). Based upon this model the Index of Learning Styles (ILS) instrument was developed by Felder and Soloman (Felder, 1996) consisting of 44-item questionnaire for identifying the learning styles. It classifies students on four types of dimensions, having eight categories (active/reflective, sensing/intuitive, visual/verbal and sequential/global). Many a times the teaching styles of teachers in the colleges become in-compatible in many dimensions and as a result students do not find class interesting and acquire negative attitude towards a course/subject. This situation sometimes also lead them switch to other courses. If the teachers know their students' learning styles, they are better able to adapt teaching styles and strategies to fine-tune their teaching, to cater the needs of the students. It will be a good idea to inform students about their learning style and the type of learning style which can aid learning physics, so that they can explore and enhance their learning strengths and work on their weaknesses. Thus, instead of traditional approaches to teach physics at undergraduate level, there is a need to adopt research based approaches.

## TRADITIONAL TEACHING

At undergraduate level the traditional method of teaching physics in classroom consists of 'chalk and talk' way which is entirely teacher-centered and one way. In this case, the students adopt a role of passive robots in the classrooms and consider the teacher as the inventory of knowledge. Lectures are delivered in the classrooms but very less effort is made to engage learners and assess their level of comprehension. Sometimes teachers do ask questions after the delivered lectures but the problem is only few enthusiastic students respond and this promotes non-participation of the students. This further makes it difficult to reveal the misconceptions or learning gaps occurring in the mind of the students.

One of the main focus of PER is to have a curricula which encourages active learning and peer cooperation. Some of the research-based strategies like Workshop Physics (Laws, 1995) Tutorial base instructions (Redish et al., 1997), Socratic dialog lab (Hake, 1992), Active Learning Problem Sets (Van Heuvelen, 1991), Peer Instruction (Mazur, 1997) and Just in Time Teaching (Novak et al., 1999) have been tested empirically and showed students' gain in effective learning and understanding. With experience a teacher giving a lecture can come to know when students do

not understand the material provided to them. But real challenge is to find, why they are confused what are their misconceptions and how to overcome them.

This paper is intended to present a case study which has been built upon implementation of one of the researched-based teaching pedagogy, Peer Instruction and use of Clickers.

## RESEARCH QUESTIONS

The following research questions were posed in this study:

- Does use of clickers improve the understanding of the subject?
- Does use of clickers increase participation and interaction in the class?
- Does use of clickers improve grades of the students?

## METHODOLOGY

Authors used the tool known as ILS to explore the learning styles prevalent among the students studying physics in a three years degree course of Bachelor of Science (BSc) of Himachal Pradesh University at four different colleges of the Shimla city in India. The ILS questionnaire was administered to 424 students and they took around 15–20 min to complete the questionnaire. The result of this study revealed that majority of these undergraduate students studying physics are *active, sensing, visual and sequential* type of learners (Sharma and Ahluwalia, 2012).

The requirements of four (reflective, intuitive, verbal and sequential) learning styles, out of the eight categories mentioned earlier are met more or less by traditional lecture-based teaching method, which is generally followed in colleges, but for other four dimensions (active, intuitive, visual and global) some additional teaching aids are required.

Research has proved that interactive teaching/learning methodology is more advantageous for both teachers and students. There are number of tools and technologies available to make teaching more interactive and engage students using three H's: Head, Heart and Hands. One of such tools is Students Response System or Clickers. Clickers are hand held wireless electronic devices, which students in a classroom can use to answer the multiple choice questions projected through a LCD on a large screen placed in front of them and provide real-time feedback to the instructor instantly by displaying a graph that shows how the class responded (Duncan, 2005; Martyn, 2007). Research has also shown that this method offers students a significant advantage on learning the concepts of the topic being taught (Draper et al., 1996; Hake, 1997; Inverno et al., 2003; Massen et al., 1998). Clickers' technology consists of three components:

- transmitters also called Clickers
- receiver
- software.

Each clicker is provided with a unique number which is used to identify a students ID number with a particular clicker device. Many different strategies can be employed with clickers. In the present case study, clickers were blended with peer instruction strategy. Peer Instruction methodology starts with a brief lecture of 10–15 min which is an average attention span of human beings. Then multiple choice conceptual questions are presented to the class. Questions are designed on scientifically accurate concepts and prevalent student misconceptions. Students try to pick out the right answer from a number of distractors and give their responses as A, B, C.… . The instructor gets instant feedback and if majority gets it then he/she proceeds to next concept. If majority does not get it, then he/she tries to identify and address specific misconceptions. This method makes the class interactive. As voting makes students commit to an answer (they cannot hide), students realise that even others are also struggling. After posing the question, 30 sec to 1 min is given to students to read and process question individually another 30 sec are taken to collect vote. After 1–2 min discussion in groups, students sent their second vote. In this whole strategy, the important steps are to identify and choose the content area to define important concepts, learning objective that is, what students will be able to do after they understand the question and also to decide the role of the question. Clicker questions designed so can be used as quiz for grades, to survey students to find their background, to test conceptual understanding, etc.

## CLICKERS IN CLASSROOM

To bring changes in physics instruction in the classroom, PER-based technological innovation and specific instructional intervention called Classroom Response System or Clickers was used. The class of BSc third year students was converted into clicker class room. Where Hyper-Interactive Teaching Technology (H-ITT) Students Response System software was installed Students were asked specially designed, Multiple Choice conceptual questions on various topics of Solid State Physics course. Questions were having scientifically accurate concepts and prevalent student misconceptions. Such questions helped us to:

- engage all students in classroom and activate learning
- explore preexisting knowledge of students
- increase student involvement and attention
- assess student's understanding and get instant feedback
- know whether the lesson is sinking in
- practice solving problems
- change the monotony of passively taking notes
- increases interaction with the teacher and students
- identify attitudes, values, opinions
- take attendance.

Clicker questions can be of different types. The types of clicker questions used in this case study were:

1. *Recall Questions*: Such questions are designed to recall facts, concepts or techniques relevant to class. They are often used to see if students did reading, remember important points from prior class. These questions do not test the concepts for example, one of the question posed to students was

   *Q: Wiegner-Seitz cell is a mathematical model needed to describe the symmetry of crystalline material and has*

a. *maximum volume*
b. *minimum volume*
c. *zero volume*

2. *Conceptual Questions*: Such questions probe how well students actually understand a specific concept. Answer choices of these questions are based on common student misconceptions. These questions work well if teacher identify and address these misconceptions for example,

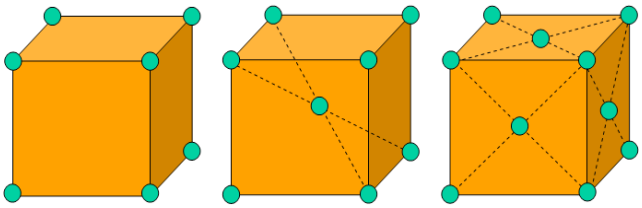
*Q: Which of these rectangles does* ***not*** *have reflection symmetry?*

*(i)* *(ii)* *(iii)*

*(a) i* *(b) ii* *(c) iii*

3. *Application Questions*: These questions require students to apply their knowledge and understanding to particular situations and contexts. Application questions often ask students to make a choice in a given scenario, connect course content to 'real-world' situations and predict the outcome of experiments.

*Q: Lattice points per unit cell for the following structures are respectively:*



*(a) 1,2,4* *(b) 8,10,12* *(c) 0,1,3* *(d) –2, 4, 8*

## DISCUSSION

Students perceptions on using clickers were evaluated by using a survey which was based upon seven questions and used a Likert Scale from 1 (strongly disagree) to 5 (strongly agree). Result is given in Table 1.

The high mean score obtained indicates that students were benefited with the use of this strategy.

**Table 1 Perception Survey Result on the use of Clickers***

| *Survey Question* | *Mean* |
|---|---|
| Participation with clickers improved my grade in the course. | 4.5 |
| Participation with clickers improved my understanding of the subject. | 4.4 |
| Participation with clickers increased my feeling of belonging in this course. | 4.3 |
| Participation with clickers increased my interaction with the teacher. | 4.6 |
| Participation with clickers increased my interaction with the other students. | 4.2 |
| I enjoyed participation with clickers. | 4.7 |
| I would recommend using clickers in other courses also | 4.6 |

*Strongly Disagree = 1; *Disagree = 2; *Unsure = 3; *Agree = 4; *Strongly Agree = 5

## CONCLUSION

The study of learning styles of students, by using ILS questionnaire, helped us to illustrate the dominant learning styles of undergraduate students studying physics and to evaluate the way they prefer to learn or process information. The responses obtained indicated that majority of the students are active, sensing, visual and sequential types of learners. Thus ILS survey has acted as a useful tool to find out the mode in which students learn. We also realised that teaching styles of teachers in the colleges is in-compatible in many dimensions and there exists a mismatch between learning styles of most of undergraduate students and traditional teaching styles in physics education. This trend can lead to students acquiring a negative attitude towards a course/subject and switching to other courses as they will not find classes/courses interesting. The requirements of four (intuitive, verbal, reflective and sequential) learning styles, out of eight categories of ILS are catered more or less by traditional lecture-based teaching method, but for other four dimensions some additional teaching strategies are required. For example in the traditional lecture-based classes active learners never get to do anything and reflective learner is never given time to reflect. Sometimes the poor performance of a student in a course or particular activity may be misinterpreted as lack of his/her knowledge or ability. Whereas, this can be due to his/her incompatibility with a particular style of learning. Research has shown that if students are taught according to their preferred learning style they become better learners, achieve higher grades and have more positive attitudes about their studies, greater self-confidence, and more skill in applying their knowledge in courses.

To have success in work and life students must function well in each category. The primary goal of a teacher is to help students to develop the characteristics of each category. He can tailor his/her lecture using some of the extra PER-based techniques to fulfill the needs of most of the students, to improve retention rate and their performance. This way quality of physics education can be enhanced. In a class students of diverse learning styles sit, as a teacher one does not have to find out the learning style of each student but at least one can take care of each side of every learning style dimension by using small number of additional innovative teaching aids.

This exercise has also helped to develop strategies to enhance the learning potential, motivation and engagement of students into learning of physics. A new pedagogy using a powerful and flexible tool Clicker, for teaching physics to undergraduate classes was used and BSc third year students' classroom was converted into clickers' classroom. It was found that this technology in classroom has helped to increase the interaction between students and has an immense potential to make both teaching and learning more effective, more efficient more engaging and more fun. Maximum students were having positive attitude towards the use of clickers and use of clickers had definitely improved students' perceptions of understanding of physics. The important thing is that clicker questions should be properly designed focusing on specific concept and learning objective.

It is obvious that clickers can be used as a tool for promoting active learning in the classroom which can enhance critical thinking and problem solving skills of learners. In future this pedagogy will be applied to other undergraduate classes and additional functions of the software will be used to transform undergraduate physics education.

## REFERENCES

Awang, M. (2006) 'Cooperative learning in reservoir simulation classes: overcoming disparate entry skills', *Johnson State Education and Technology*, Springer, Netherlands, Vol. 15, No. 3.

Crouch, C.H. and Mazur, E. (2001) 'Peer instruction: ten years of experience and results', *American Journal of Physics*, Vol. 69, No. 9, pp.970–977.

Inverno, D.R., Davis, H. and White, S. (2003) 'Using a personal response system for promoting student interaction', *Teaching Mathematics and its Applications*, Vol. 22, No. 4, pp.163–169.

Draper, S.W., Brown, M.I., Henderson, F.P. and McAteer, E. (1996) 'Integrative evaluation: an emerging role for classroom studies of CAL', *Computers and Education*, Vol. 26, Nos. 1–3, pp.17–32.

Duncan, D.K. (2005) *Clickers in the Classroom*, New York: Pearson/Addison-Wesley.

Seymour, E. and Nancy, M.H. (1998) 'Talking about leaving: why undergraduates leave the sciences', *Higher Education*, Vol. 36, No. 1, pp.115–116.

Felder, R.M. and Silverman, L.K. (1987) 'Learning styles and teaching styles in engineering education', Presented at the 1987 *Annual Meeting of the American Institute of Chemical Engineers*, New York.

Felder, R.M. (1996) 'Matters of style', *ASEE Prism*, Vol. 6, No. 4, pp.18–23.

Felder, R.M. and Silverman, L.K. (1988) 'Learning styles and teaching styles in engineering education', *Engineering Education*, Vol. 78, No. 7, pp.674–681.

Hake, R.R. (1998a) 'Interactive-engagement versus traditional methods: a six thousand–student survey of mechanics test data for introductory physics courses', *American Journal of Physics*, Vol. 66, No. 1, pp.64–74.

Hake, R.R. (1998b) 'Interactive-engagement methods in introductory mechanics courses submitted', *Journal of Physics Education Research*.

Hake, R.R. (1992) 'Socratic pedagogy in the introductory physics lab', The Physics Institute of Physics, Statistical Research Center, Enrollments and Degrees Report, Available at: http://www.aip.org/statistics.

Laws, P.W. (1995) *Workshop Physics Activity Guide*, John Wiley & Sons.

Martyn, M. (2007) 'Clickers in the classroom: an active learning approach', *Education cause Quarterly Magazine*, Vol. 30, No. 2.

Massen, C., Poulis, J., Robens, E. and Gilbert, M. (1998) 'Physics lecturing with audience paced feedback', *American Journal of Physics*, Vol. 66, pp.439–441.

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

Novak, G.M., Petterson, E.T., Gavrin, A.D. and Christian, W. (1999) *Just-In-Time-Teaching: Blending Active Learning with Web Technology*, Prentice Hall.

Redish, E.F., Saul, J.M. and Steinberg, R.N. (1997) 'On the effectiveness of active engagement microcomputer-based laboratories', *American Journal of Physics*, Vol. 65, No. 1, p.45.

Sharma, S. and Ahluwalia, P.K. (2012) 'A mismatch between learning styles and teaching styles, its influence: an empirical study', *Journal of Research: The Bede Athenaeum, Vol. 3, No. 1, pp.52–55.*

Van Heuvelen, A. (1991) 'Learning to think like a physicist: a review of research based instructional strategies', *American Journal of Physics*, Vol. 59, No. 10, pp.891–987.

## BIOGRAPHICAL NOTES

**Sapna Sharma** is an Associate Professor in the Department of Physics at St. Bede's College, Shimla, Himachal Pradesh, India, having a teaching experience spanning over 23 years. Currently, she is carrying on her research in the field of Physics Education Research (PER). Her work mainly focuses on the understanding of conceptual difficulties of students studying physics at undergraduate level through the development of appropriate diagnostic and assessment tools like concept inventories. Along with this she has also carried out extensive attitude surveys about physics using MPEX in the state of Himachal Pradesh. Under a UGC minor research project she has created clicker classroom environment for interaction with her students during the delivery of content in the physics classroom. She has presented several papers in national and international conferences and is having many publications in reputed journals to her credit.

**P.K. Ahluwalia** is a Professor in Physics, Dean Planning and Teachers Matters at Himachal Pradesh University, Shimla, India and Vice President, Indian Association of Physics Teachers. He has got a rich teaching experience spanning over 35 years. His primary research areas are theoretical condensed matter physics and physics education research. He has got more than 100 publications to his credit. He has also written books on computational physics and use of computers in computational physics laboratory. He has been involved in popularisation of science through features and talks on radios for the last three decades. He has been awarded the best teacher and academic administrator award by Himachal Pradesh University in 2012.