Pen-Input Computing and Dyknow Software: Pedagogical Opportunities for Interactive Physics Instruction

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Introduction

- **DyKnow software** (www.dyknow.com) is designed to promote engaged classroom communication through variety of venues for real-time feedback and information exchange among all participants in the learning process.
- **Pen-based computers such as Tablet PCs** provide a critical advantage in fields where formula writing, graphing, schema sketching or free drawing play a vital role (mathematics, sciences at large, engineering and art as well as Japanese language, music, special education, medical imaging etc.)
- This paper describes modalities and summarize results of using DyKnow software and Tablet PCs in several college level, introductory physics and physical sciences courses at several universities.

Tablet PC & DyKnow Instruction

Results

Louisiana State University Shreveport
Sisson (2009)

DyKnow and university-provided Tablet PCs deployed in:
1) Algebra-based and Calculus based Introductory Physics Courses: Results compared with 5 year department averages in semesters without deployment.

	Conceptual Understanding (FCI)	Problem Solving (Final Exam)	Course Success (% A, B, C)
Algebra-based Physics I (n = 39, Fall 07)	7% increase (p = 0.14)	2% improvement 67% → 69% (p = 0.64)	22% increase 57% → 79% (more than 2σ)
Calculus-based Physics I (n = 26, Fall 08)	3% increase (p = .99)	11% increase 56% → 67% (p = 0.05)	10% increase 56% → 67% (more than 1σ)

Fort Hays State University
Hrepic at al. (2007, 2009b)

DyKnow and university-provided Tablet PCs deployed in:
1) Calculus-based Modern Physics Course: Results compared with previous semester without deployment. Same instructor, curriculum and textbook.
2) Concept-based Physical science course: Results during three semesters of deployment compared with three semesters without deployment. Same instructor, curriculum and textbook.

| Course	Semesters	DyKnow used	N	Pre-Test Score Mean (+/- SD)	Post-Test Score Mean (+/- SD)	Normalized gain Mean (+/- SD)
Modern Physics	F05	NO	10	NA	75.8% (+/- 10.5%)	NA
	F06	YES	13	NA	82.5% (+/- 15.9%)	NA
Physical Science	F04,S05,F05	NO	103	38.8% (+/- 16.3%)	73.9% (+/- 13.1%)	56.8 (+/- 20.0)*
	F07,S08, F08	YES	80	37.8% (+/- 16.7%)	69.6% (+/- 18.3%)	51.5 (+/- 26.0)*

*p< 0.01;

Columbus State University
Hrepic and Shaw (2010)

DyKnow and voluntarily brought students' personal computers deployed in:
1) Algebra-based Introductory Physics Course: Results compared success in the same class based on how much they used technology. Same class so – same instructor, curriculum, textbook, tests etc ...

Classroom Observation Results

Advantages
- **More interaction for the whole class**
- **Easy to go back and review material**
- Helps students organize notes
- **Allows you to focus on content, not note-taking**
- **Can check status button without embarrassment**
- Can telecommute to class

Disadvantages
- If you have **no computer**, you are at a **disadvantage**
- **Technical issues** can eat up class time.
- **Temptation to check email during class**
- **Couldn't take notes by hand if using laptop in class**

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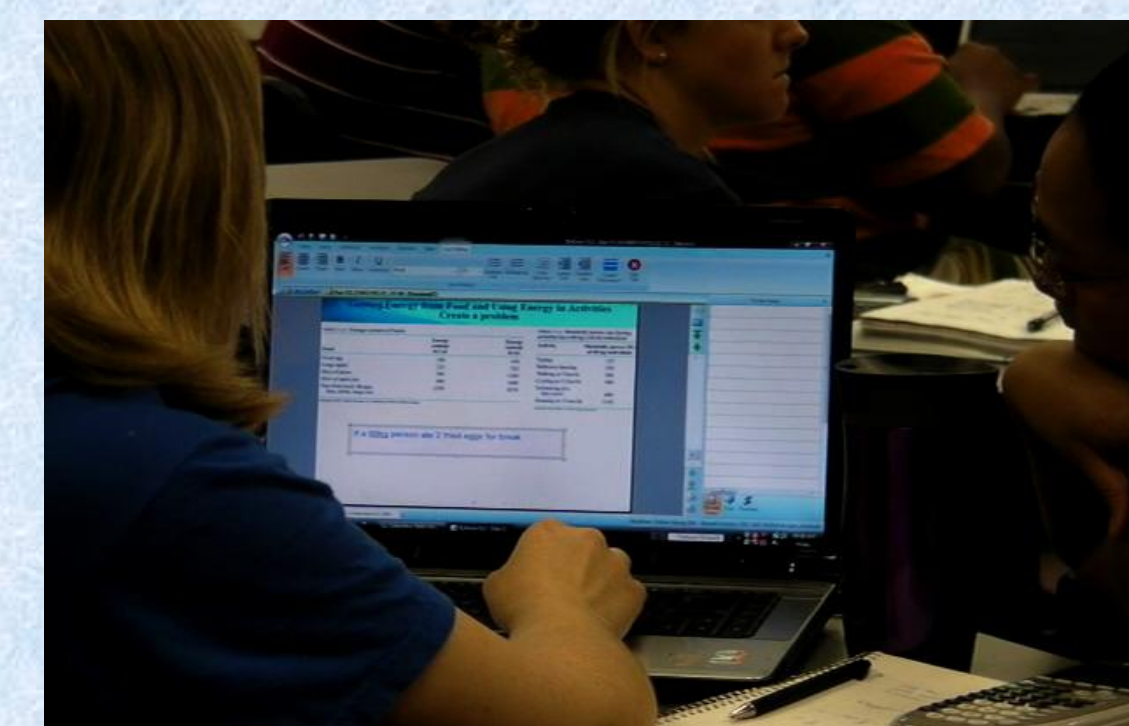
Test and Survey Results
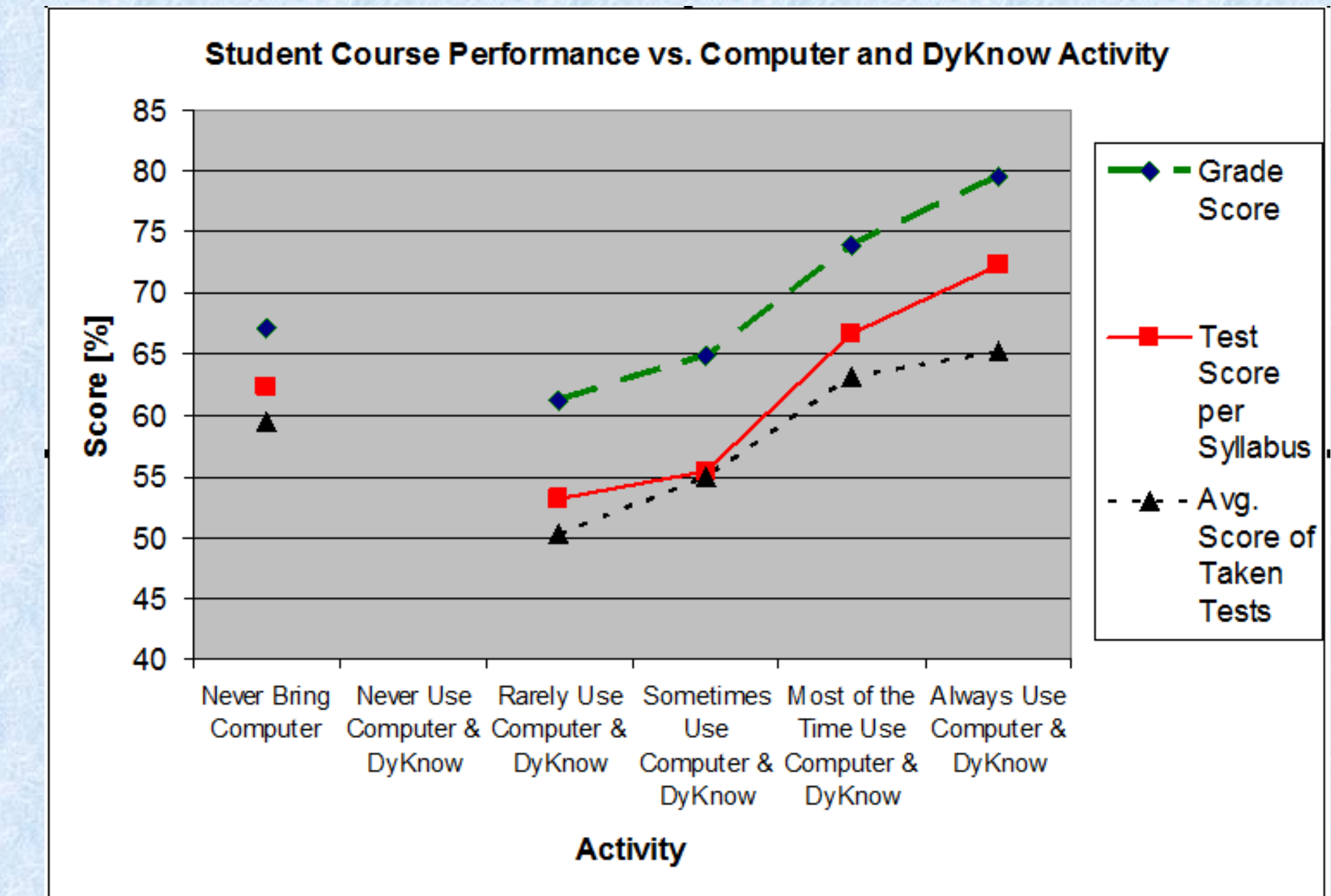
Students' scores measured against Cumulative Computer Presence and DyKnow Activity

Students' Perceptions on Productivity of Using DyKnow Software in Teaching (FHSU and CSU Deployments)

The top mobile computer I own	Category Code	N	Avg. %	SD
Avg. Scores Of Taken Tests	All: 2	53	55.53	25.15
Tablet	1	4	81.96	3.67
Other	0	49	53.38	24.93
Mann-Whitney (2 groups)			p=0.016	
The top mobile computer I own	Code	N	Avg. %	SD
Course Grade Result	All: 2	53	64.44	27.57
Tablet	1	4	90.29	2.36
Other	0	49	62.33	27.62
Mann-Whitney (2 groups)			p=0.040	

Students' Attitudes and Recommendations (FHSU and CSU)

Students' Perceptions on Productivity of Using DyKnow Software in Teaching (FHSU and CSU Deployments)

Category of DyKnow Evaluation	General Positive Aspects			General Negative Aspects			Cognition		Communication		Motivation	
Students (%) who Agree and Strongly Agree Statement: Using DyKnow …	…was enjoyable	…made learning more fun	…was very challenging	…was very frustrating	…was a waste of time	…helped me take better set of notes	…facilitated my learning	…enhanced my understanding of the course material	…enhanced my interaction with classmates	…enhanced my interaction with the instructor	I was more attentive when DyKnow was used	I was more motivated when DyKnow was used
Modern Physics (Calculus-based, FHSU) Fall06 (N=9/10)	88.9	77.8	11.1	33.3	0.0	66.7	88.9	62.5	88.9	77.8	44.4	33.3
Physical Science (Concept-based, FHSU) Sum06–Fall08 (N=76/91)	92.1	90.8	10.5	5.3	3.9	61.8	89.3	82.9	77.6	86.7	69.7	70.7
General Physics (Algebra-based, CSU) Spring10 (N=37/33)	81.1	75.7	24.3	24.3	27.0	51.4	64.9	67.6	67.6	70.3	59.5	59.5
Weighted average across courses	88.5	85.3	14.7	13.1	10.6	59.0	81.9	76.8	75.4	81.1	64.7	64.5

Students' Recommendations for Future Usage of DyKnow Software and Tablet PCs in the Physics Courses They Took (FHSU and CSU Deployments)

Students (%) enrolled in	Recommend to keep in the Physics course:	Definitely Yes	Yes	Neutral	No	Definitely No
Modern Physics (Calculus-based, FHSU) Fall06 (N=9/10)	DyKnow	11.1	44.4	44.4	0.0	0.0
	Tablet PCs	22.2	66.7	11.1	0.0	0.0
Physical Science (Concept-based, FHSU) Sum06–Fall08 (N=76/91)	DyKnow	50.0	38.0	12.0	0.0	0.0
	Tablet PCs	50.0	41.7	6.3	2.1	0.0
General Physics (Algebra-based, CSU) Spring10 (N=37/33)	DyKnow	24.3	37.8	18.9	8.1	10.8
	Tablet PCs	24.3	27.0	29.7	13.5	5.4
Normalized average (to 100%) across courses	DyKnow	28.5	40.1	25.1	2.7	3.6
	Tablet PCs	32.2	45.1	15.7	5.2	1.8

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* Author's papers available at www.hrepic.com