Comparison of Student Learning in Challenge-based and Traditional Instruction in Biomedical Engineering

Others:

Taylor Martin , Stephanie D. Rivale, and Kenneth R. Diller

The University of Texas, 2007

Presenter:

Hanaa Torkey

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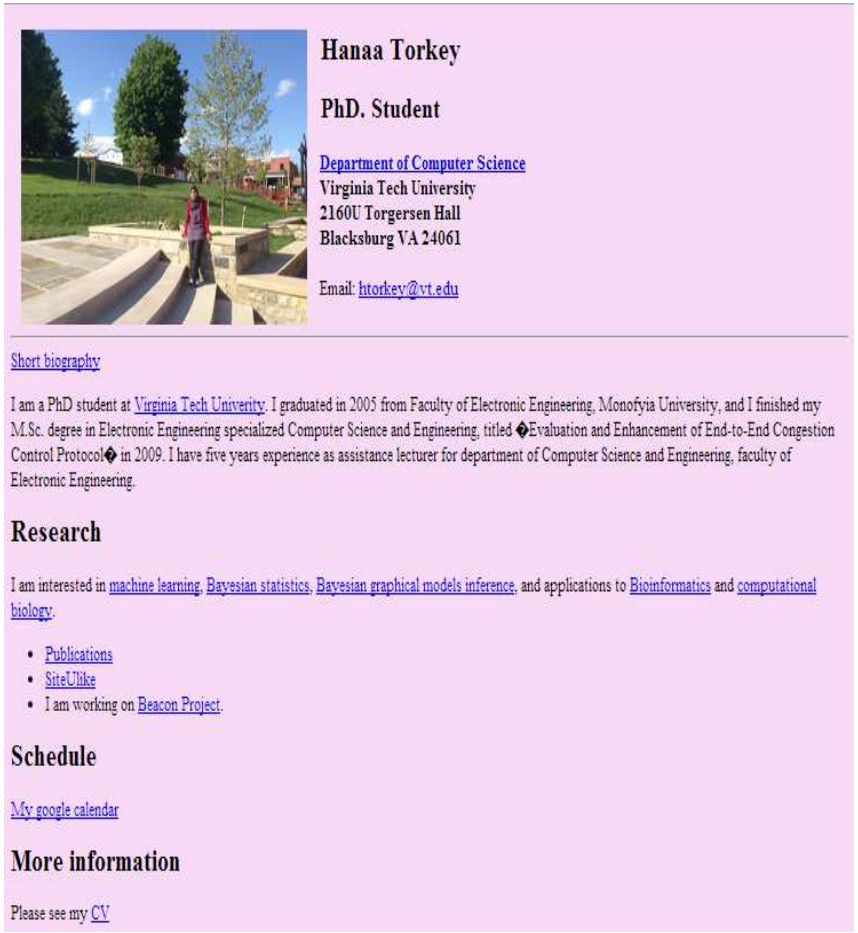
About Me

- **Undergrad and Master** in Computer Science and Engineering, Faculty of Electronic Engineering, Menofia University, Egypt
- 2nd PhD student at Computer Science department, VT
- **Working on:**
  - Computational Biology and Bioinformatics: Gene regulatory networks inference
- **Projects:**
  - GenomeID
  - Somatic Mutations in Cancer
  - Beacon: Pathway inference in plants



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Short biography

I am a PhD student at Virginia Tech Univerity. I graduated in 2005 from Faculty of Electronic Engineering, Monofyia University, and I finished my M.Sc. degree in Electronic Engineering specialized Computer Science and Engineering, titled "Evaluation and Enhancement of End-to-End Congestion Control Protocol" in 2009. I have five years experience as assistance lecturer for department of Computer Science and Engineering, faculty of Electronic Engineering.

Research

I am interested in machine learning, Bayesian statistics, Bayesian graphical models inference, and applications to Bioinformatics and computational biology.

- Publications
- SiteUlike
- I am working on Beacon Project.

Schedule

My google calendar

More information

Please see my CV

Website: http://bioinformatics.cs.vt.edu/~htorkey/

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Introduction

- The motive of the study is that engineers successful performance requires skills in both technical expertise and innovation skills
- Biomedical engineers need a solid understanding of the fundamental knowledge in the field, Also they should be able to adapt as opportunities and applications in this field evolve.

Routine Experts vs. Adaptive Experts

- **Routine experts:**
  - Technically proficient in their established domains of knowledge and application
  - Fail to adapt their expertise in a new context when facing a novel problem
- **Adaptive Experts**
  - Strong technical proficient in their domain, like RE
  - Flexible in developing appropriate responses and solutions in novel situations

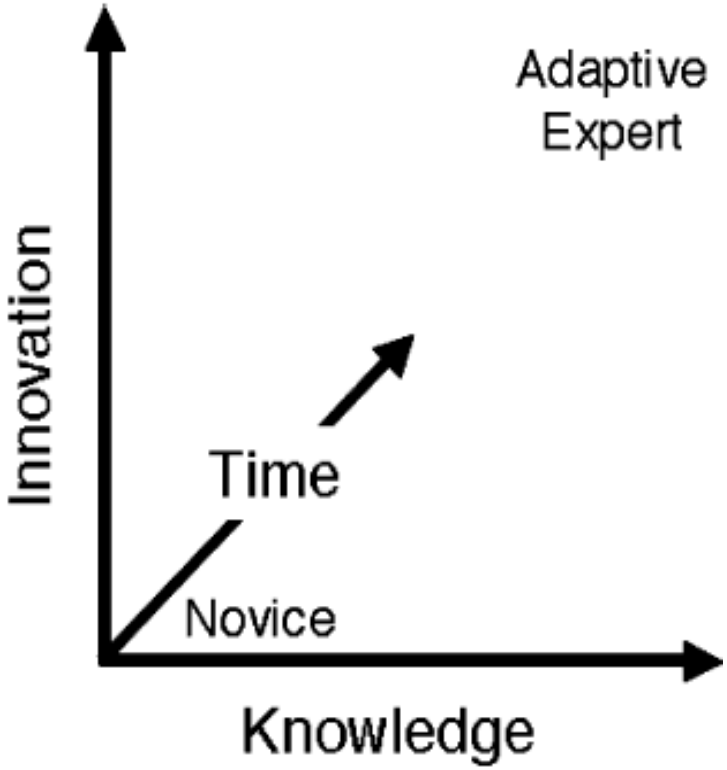
What is common between adaptive experts and computational thinkers ?

Main Questions

- How AE is developed?
- How different educational methods influence AE development?

How People Learn

- HPL is a model for the development of AE in the processes of learning and the transfer of learning
- The model proposes that there are two essential and complementary dimensions of AE:
  - Knowledge
  - Innovation
- Which educational experiences that best promote both knowledge and innovation in the context of a semester-long formal course?



Knowledge covers the taxonomic understanding of the field.
innovation involves the ability to perform in novel situations

Traditional lecture format vs. Inquiry Learning

- Traditional lecture format:
  - Effective at developing the knowledge dimension of AE
  - Often fail to improve students' innovation
- Inquiry Learning methods:
  - Frequently effective at developing the innovative dimension of AE
  - If not structured correctly, can fail to help students improve on the knowledge dimension.

- How to relate these methods of learning to computational thinking learning?

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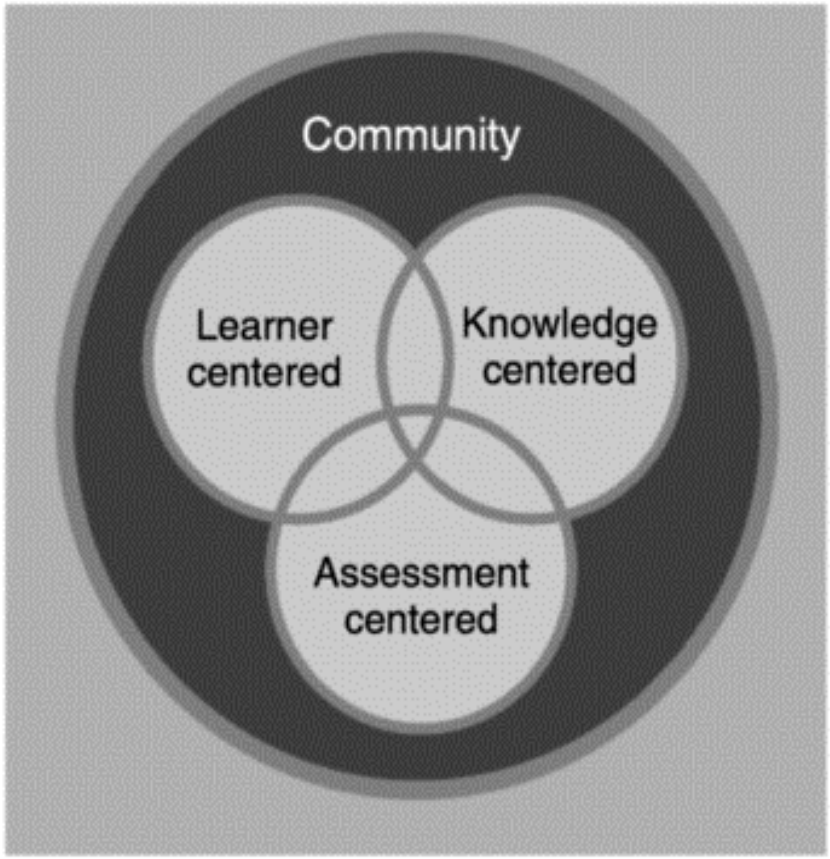
HPL *Perspectives on learning environments*

- Key principles for designing learning environments:
  - Realistic problems (Community)
  - Knowledge centered
  - Assessment centered
  - Learner centered



National Research Council report
‘‘How People Learn’’

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Structuring Learning Environments for Productive Inquiry

Relate each phase to knowledge or/and innovation??

The STAR Legacy (SL) Cycle.

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Transfer In – Transfer Out

- Transfer in: is using prior knowledge to interpret new situations and learn from them
- Transfer out: is using knowledge learned in one situation to solve problems in another

- Which phase is transfer in/out?
- Is CT transfer in/ out or both?

Methods

- Experiment
  - Using HPL principles implemented through the SL Cycle in biotransport course.
  - The course was taught at multiple institutions via HPL and traditional formats
  - A pretest and posttest to two traditional format classes and two HPL format classes.
- **The test**:
  - Knowledge: set of multiple-choice questions that any general course in biotransport should have prepared students to answer (2 Q, 3 part each, 10 min)
  - Innovation: by examining students' performance on a novel problem that asked them to solve a real world (15 min design)

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Participants

- 136 students participated in the study (106 completed both the pre and Posttests)
- Most of these students were in their third year of undergraduate study.

	HPL condition	traditional condition
Total no. of student	58	48
gender	18 F / 40 M	13 F / 35 M
SAT math	M = 710, SD = 80	M = 702, SD = 112
SAT Verbal	M = 668, SD = 97	M = 668, SD = 97

Materials

- Traditional classes :
  - Focused around instructor lectures that followed the order of knowledge presented in the textbook
  - Student activities: textbook readings, lectures, question and answer sessions, homework assignments, tests, and quizzes.
- HPL classes:
  - Using 10–13 SL modules that addressed fluid, heat and mass transport processes in biological systems.
  - Modules ordered with two goals
    - To ensure that students learned the targeted biotransport taxonomy
    - To lead the students through a learning sequence starting with core fundamentals and progressing to acquisition of specific analysis tools.

Assessments and Coding

- **The knowledge section** measured students understanding of fundamental principles of bioheat transfer.
- **The innovation section** measured how students use the knowledge and tools of bioheat transfer to analyze a state-of-the-art research problem.
  - Use coding scheme to capture the students adaptive reasoning in novel situations
- Knowledge assessment:
  - questions with well-defined correct answer.
  - The student's knowledge score was the number of multiple-choice questions out of six answered correctly

Assessments and Coding

- Innovation assessment:
  - Measuring the adaptive reasoning by measuring the student transfer in useful and knowledge and procedures to the innovation problem.
  - Examining whether students considered the problem globally and expanded the problem space by considering the system and its interactions with the environment.
  - Measuring efficiency by examining whether students applied appropriate governing principles and constitutive equations to model the process in the problem.
  - Code from 0 to 3 for each level of innovation in solving the problem

Code for innovation assessment

	Innovation		Efficiency	
Code	System	Interactions	Governing principles	Constitutive equations
0	Absent	Absent	Absent	Absent
1	Picture or written description present but missing heat exchanger	Incorrect interactions	Incorrect governing principles	Incorrect constitutive equation(s)
2	Heat exchanger, fuel source, patient are all included in the system	One or more but not all (of 3) interactions: correct heat transfer to the blood, heat transfer from the fuel and heart as pump	Conservation of energy or momentum only	One or more but not all (of 4) correct: heat source from burner, convective exchange to blood, force of pumping, F > flow resistance
3	System is heat exchanger, that interacts with butane and person	All three correct	Both conservation of energy and momentum	All four correct

What do you think about this coding scheme in assessing computational thinking concepts, Abstraction , modeling, ……. ?

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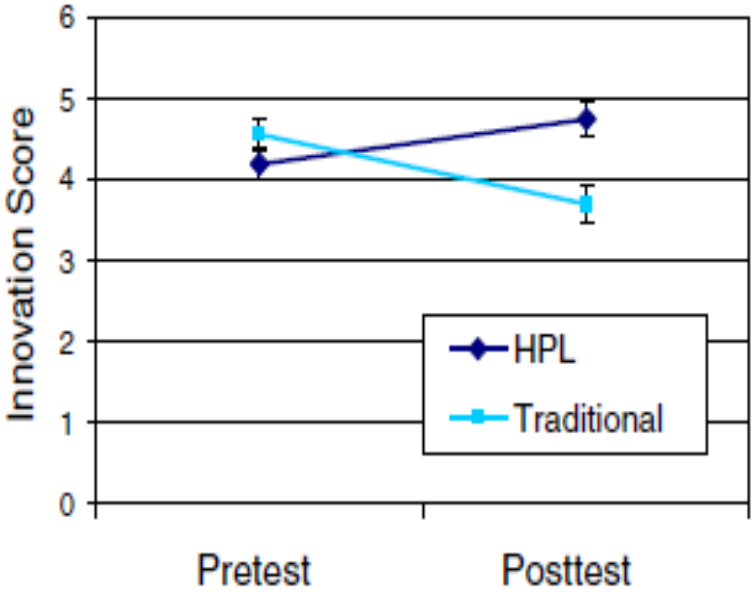
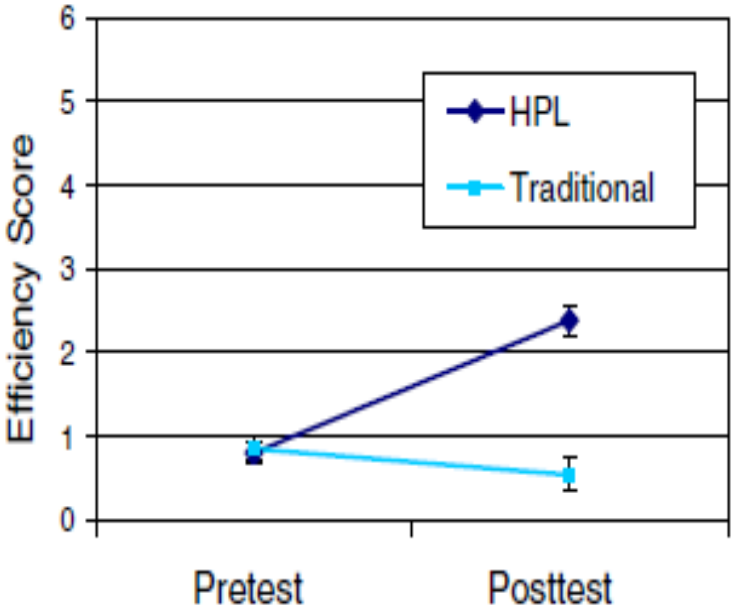
Procedure

- Students took the pretest on the first day of class prior to any instruction, and the posttest on the last regular class day.
- Examining both pre–post changes in and between group comparisons of student performance on three measures: the knowledge section and the two scores for the innovation section

RESULTS

- Knowledge Section:
  - All of the students improved on this multiple choice test over time
- Innovation Section:





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DISCUSSION

- HPL framework of learning is more effective and better suited to undergraduate engineering students developing AE skills
- They relate the significant decrease in innovation performance for the traditional students to the potential long-term effects of traditional instruction learning method.

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Conclusion

- HPL and traditional students test scores were compared results show that HPL and traditional students made equivalent knowledge gains, but that HPL students demonstrated significantly greater improvement in innovative thinking abilities.

Thanks

- Questions ???
- Comments
- Observations