Teaching Using Technology:
Exploring the World of Worked Examples

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Abstract

Worked Examples (WE), a step-by-step process task demonstration, facilitate learning in traditional classrooms, often using technology. Technology use may be as simple as clickers or more complex, such as scaffolding. A new conceptualization of worked examples includes a step-by-step process demonstration of a problem or concept in an entirely online format.

The purpose of this presentation is to highlight the use of worked examples along a broad range of technology mediums. One extreme includes a traditional approach in a physical classroom setting where select worked examples are chosen to engage students. A moderate instance of technology use involving worked examples includes hybrid classes, or using traditional class approaches in online courses. The second extreme uses worked examples in only online formats. For this second extreme, there is no concept of teaching in a traditional classroom.

Comparisons and discussion of approaches along the technology use continuum will be the crux of this presentation. Qualitative responses from university professionals who use WE in teaching will provide transcripts for review. Styles and techniques of university professionals, as well as best (and worst) practices, will be presented. Results indicate teaching needs to drive the use of technology.

Overview

1. Worked Examples (WE) Background
2. Qualitative Study Outline
3. Findings

Worked Examples Defined

Traditional (1)

- Traditional:
  - are a highly structured step-by-step demonstration process of how to complete a problem or perform a task, with a solution.

Technology (2)

- Technology:
  - multiple technology mediums can be used as facilitating examples for dialogue and discussion to create a community of learning.

Worked Examples Defined

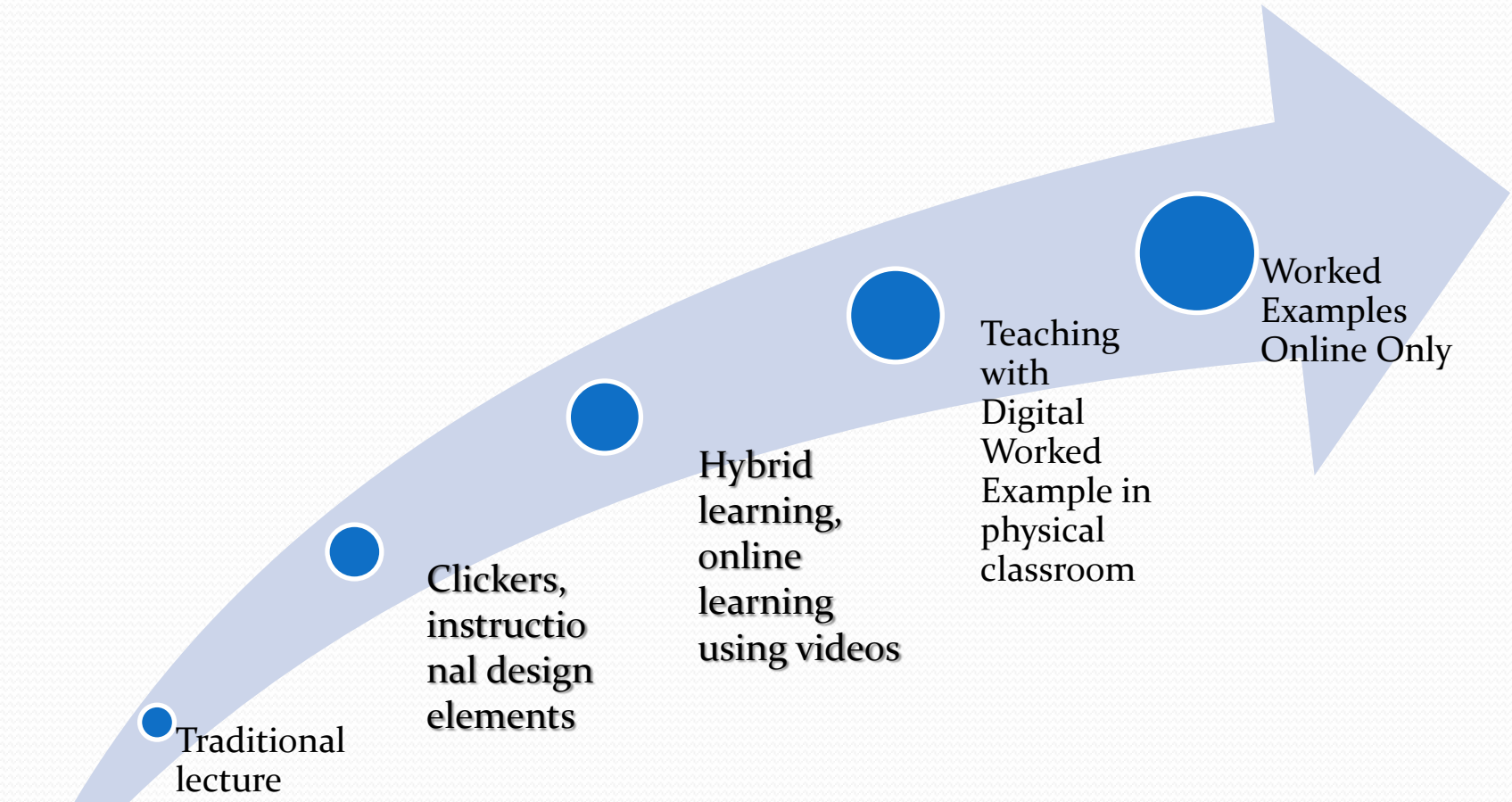
Traditional (1)

- Traditional:
  - Creator-as-expert disseminating knowledge.
  - Emphasizes individual constructivist learning

Technology (2)

- Technology:
  - Emphasizes sociocultural, contextual learning

Use on a Technology Continuum



Supporting Learning Theories

- Cognitive Load theory
  - Optimal amount of mental effort for a task
- Instructional Design
  - How to incorporate scaffolding

History

- Strongly linked to cognitive psychology
- 1980s
  Problem-Based Learning
- 1990s
  Applied contexts
- 2000 – present
  STEM fields

Technology Influences

- How to introduce examples in new ways (scaffolding)
- How to get student feedback in new ways
- Increased satisfaction by having a process-focused approach

Scaffolding

Traditional Framework

- When to deliver select elements of the example
- When to use select supporting elements (fading)

Technology Framework

- Instructional design, figuring out the best processes and timing to engage the learner(s)
- Adherence to structure allows for Worked Example vs. Guided Design

Technology Influences

Worked Examples

http://workedexamples.org/

Working Examples

http://workingexamples.org/

Effectiveness through Research

- Context is key
- WE are better for novice learners
- WE are more efficient than PBL alone

Effectiveness through Research

- Self-explanations can increase test scores
- Increase attitudes & motivation
- Decreased anxiety

How Worked Examples are Assessed

Literature Review:

- Tests
- Quizzes
- Self-Explanations
- Focus Groups

Respondents:

- Tests without grades
- On-the-spot problems
- Pair / Group discussions

Problems with WE

- Context-specific
- Ceiling and floor effects
- Poorly chosen examples
  - Too complex
  - Not targeted to audience
- Nesting within curriculum

Study Methodology

- Qualitative interviews of university teachers who used WE
- Purposeful Sampling
  - Lilly conference participants
  - Review of literature for respondents
  - Teaching awards
- Semi-structured interview format
  - Structured question set (15)

Respondents

- 9 respondents
- 8 out of 9 subscribed to traditional framework of WE
- Includes teachers from US (7) and Europe (2)
- Emphasized technical courses, such as statistics, computer science, psychology research

Interview Responses

Theme 1: Definition

"I think of examples as…structured scaffolding."

Theme 2: Technical Teaching Settings

" [WE are] a natural approach for topics of a technical nature, since many of these topics involve a good deal of problem solving."

Theme 3: Novel Approaches

“Since environment diagrams are pictorial, I take the students outside with sidewalk chalk and let them draw the diagrams on the sidewalk. I have other students walk around asking questions and pointing out problems with the diagrams. Since I started doing that, I feel that average case mastery of the subject has improved.”

Theme 4: “Wrong” Paths

“I present a problem and then probe the class for approaches to solve the problem. Sometimes, I let the students go down a wrong path, since it is important to recognize such paths and which choices led to the wrong path….the process is the ultimate goal.”

Theme 5: Novice Learners

"There is an immense amount of evidence that learners, especially novices, prefer to learn from examples."

Theme 5: Novice Learners-Fading

“There's the idea of fading where you maybe give them a complete worked example or two and then you give them a problem to solve they just have to do a small part of it. Then you successively give them more and more of the uncompleted part of the problem and have them do it.”

Theme 5: Novice Learners

"If you have kids on the really low end or really high end worked examples are almost too overwhelming or too easy. Tailoring the worked examples to the students prior domain knowledge is really, really important."

Theme 5: Novice Learners

"Worked examples combine the advantages of problem based learning (motivation, authenticity and so on) with lower cognitive demands (lower cognitive load) compared to "pure" problem based learning, thus facilitating learning in students with low prior knowledge."

Theme 6: Value

"The use is inevitably going to grow."

Theme 7: Satisfaction

"Well students love it. Most students, and the research shows this, they pay more attention to examples, especially math classes, than text explanations. As soon as they have a problem to solve they look for an example they can identify. Examples are very valuable to students. Faculty think they're valuable."

Theme 8: Individualism vs. Collaboration

"WE are beneficial if there is some kind of explanation or activity happening with them...if you were using a computer or interactive design, it would be easier to do with individuals."

Theme 9: Teaching vs. Technology

“If you were using a computer or interactive design, it would be easier to do with individuals."

Theme 9: Teaching vs. Technology

"Technology … might provide a better way of implementing an instructional approach but unless you have a good idea of what the learner needs to know, unless you have an idea of what to use, whether you do it on a piece of paper or a blackboard, the learning environment is irrelevant."

Theme 9: Teaching vs. Technology

"You've gotta have the right stuff to identify first before you figure out how to teach it."

Conclusion

Teaching needs to drive technology use.

Future Trends

"As STEM work increases, worked examples will increase, particularly through students in the field."

Future Trends

Training (Simulation) vs. Teaching

Do WE have a place in Digital Worlds?
(MOOCS, Badges, Certificates, etc.)

Future Trends

Assessment

Working examples can provide a means to provide case studies for assessment.

Interview Questions

1. Tell me about how you have used Worked Examples in teaching/training situations:
    a. What is the course about?
    b. What level course is it?
    c. How many students typically enroll in the course?
2. What are your primary teaching goals when using Worked Examples?
    a. Content goals?
    b. Skill goals?
    c. Affective goals? (e.g. satisfaction, appreciation of subject matter)
3. Please define the method, in the way that you use it in your course.
4. Do you also regularly use other methods in the course in conjunction with Worked Examples?
    a. If so, what are they?
    b. How do they work with Worked Examples?
5. How do Worked Examples help you accomplish your goals?
    a. Content goals?
    b. Skill goals?
    c. Affective goals? (e.g. satisfaction, appreciation of subject matter)

Interview Questions (continued)

6. Why did you choose to use Worked Examples?
7. Please tell me about a story, incident, or experience you have had while using Worked Examples that conveys why you feel the chosen instructional method is effective.
8. How do you prepare to teach using Worked Examples?
9. What do you do during a typical class session in which you use Worked Examples?
10. What problems do you typically encounter when using Worked Examples and how do you deal with them?
11. How can you tell that students are learning during the process?
12. How do you grade students?
13. How do you gather feedback about the course from students?
14. How do you reflect and improve for the next course?
15. Have you honed your skills in Worked Examples you typically use?
    a. Read?
    b. Attended workshops?
    c. Talked to colleagues?

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