Axiomatic Design and Implementation of Service-Oriented University Classes: Emotions and Senses

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Presentation Overview

• Introduction: Motivation and objective

• Literature review and contribution

• Axiomatic Design process
  – Stakeholder analysis
  – Customer Needs (CNs)
  – Benchmarking
  – Prototype FRs
  – Prototype DPs

• Application to a university course
  – Course design: FRs and DPs
  – Implementation and sample of the course material
  – Results and feedback

• Concluding remarks
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  - Results and feedback
- **Concluding remarks**
Introduction: Motivation and Objective (1)

• Education and the individual
  – Billions of people spend decades of their lives in modern educational systems
  – Korean families spend more than $3000/year to educate one child in addition to the public school system (Korean’s salaries are about ½ of US)
  – Education level correlates highly with salary

• Education and society
  – Education has been around for 1000’s of years
  – Education is an essential factor controlling the success of nations

• If education is so important to each person and the world...
Why do students often look like this?
Introduction: Motivation and Objective (3)

- Education is part of the service economy

- The service economy includes...

Introduction: Motivation and Objective (4)

• Can we extract the essence of other services for education?

• Starting from this question, our objective is...

“Axiomatic Design of Service-Oriented University Education”

For...
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Literature Review and Contribution (1)

• Traditional education literature
  – Knowledge taxonomies (e.g., Bloom et al., 1956)
  – Learning styles (e.g., Davis, 2007)

• Service perspective in education
  – KANO model (Kano et al., 1984)
  – SERVQUAL model (Parasuraman et al., 1985)
  – Humor in classroom (Berk 2000, Skinner 2010)

• Formal design in education
  – Quality Function Deployment (Sahney et al., 2004 and Bagchi, 2010)
  – Axiomatic Design for a specific course (Tate et al., 2004 and Tate, 2005)
  – General use of AD for course design (Thompson et al., 2009)
Literature Review and Contribution (2)

• Contribution

  – Propose the idea of a general service perspective in university courses that includes the stimulation of emotions (not only humor) and senses;

  – Develop a list of prototype FRs and DPs to support the design of courses with this general service-oriented perspective;

  – Design a university course that includes, not only educational functions, but service-oriented ones such as experiencing emotions;

  – Discuss the implementation of such a course at KAIST.
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## Axiomatic Design: Stakeholder Analysis

<table>
<thead>
<tr>
<th>Stakeholder Analysis</th>
<th>Customer Needs</th>
<th>Benchmarking</th>
<th>Prototype FRs</th>
<th>Prototype DPs</th>
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- **Stakeholders of the university education system?**
  - Almost everyone is a stakeholder of education
  - Students, teachers, parents, society...

- **10 source categories investigated**
  - University student surveys
  - Prior course evaluation survey scores and comments
  - Interviews with the KAIST Dean of Education 3.0
  - Interviews with professors who have received excellent teaching awards from KAIST
  - On-line articles and videos about teaching
  - Books on teaching authored by celebrated professors
  - A popular non-fiction Korean television program where lecturing is the format
  - Academic literature on service and education
  - Our own perspectives on what is good about various services
  - Academic literature on emotions/senses.
Axiomatic Design: Customer Needs

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- **Customer Needs**
  - 259 Customer Needs
    - 79 CNs related to the teaching staff
    - 160 CNs related to class meetings (lecture & discussion)
    - 20 CNs related to students
  - We further organized these into categories
    - Course content
    - Delivery
    - Teaching
    - Evaluation
    - Overall class experience

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Customer Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability</td>
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<td></td>
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<tr>
<td>Delivery</td>
<td></td>
<td></td>
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<tr>
<td>Teaching</td>
<td></td>
<td></td>
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<tr>
<td>Knowledge</td>
<td></td>
<td></td>
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<tr>
<td>Communication with students</td>
<td></td>
<td></td>
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<tr>
<td>Attitude</td>
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</tr>
</tbody>
</table>

- **Stakeholder Analysis**
- **Benchmarking**
- **Prototype FRs**
- **Prototype DPs**
Axiomatic Design: Benchmarking of Education and Services

**Stakeholder Analysis**

**Customer Needs**

**Benchmarking**

**Prototype FRs**

**Prototype DPs**

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**Bloom’s Taxonomy**

**Memletics Learning Styles**

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**Emotions**

Love  Joy  Surprise  Anger  Sad  Fear

**Senses**

See  Touch  Taste  Smell  Hear
Axiomatic Design: Prototype Functional Requirements

Why “prototype”?

High level Functional Requirements
– FR0: Establish student understanding of course knowledge (content) map.
– FRi: Establish cognitive domains for course topic i in students.
– FRA: Evaluate course quality.
– FRB: Establish connections between course topics and students concerns.
– FRC: Magnify intensity of emotion the student associates with selected ideas.
Axiomatic Design: Prototype Design Parameters

- Prototype DPs are simply stated as “methods to provide” the FR.

- Depending on the course topic and application, the course designer will select DPs.

- Prototype FRs and DPs can be used for generic guidance and structural placeholders.

- We provide examples of DPs for some of the FRs in our example.
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Course Design: FRs and DPs

Prototype Functional Requirements

Prototype Design Parameters

Extract

FRs for Chapter i

Matching should remain

Ordering and Allocating

Extract & Specify

DPs for Chapter i

<table>
<thead>
<tr>
<th>Time Line</th>
<th>Functional Requirements</th>
<th>Design Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0~5</td>
<td>FRCl.1: Magnify the intensity of student surprise associated with life topic 'class'</td>
<td>Sudden appearance of professor</td>
</tr>
<tr>
<td>5~10</td>
<td>FRCl.1: Magnify the intensity of student fun associated with life topic 'class'</td>
<td>Candies distribute performance</td>
</tr>
<tr>
<td>10~25</td>
<td>FRBl.1.k: Establish connection between course topic 'Network Modelling' and students</td>
<td>Food distribution examples</td>
</tr>
<tr>
<td>25~30</td>
<td>FRCl.1: Magnify the intensity of student curiosity associated with course topic 'Network'</td>
<td>Network examples which cannot be solved</td>
</tr>
<tr>
<td>30~45</td>
<td>FRCl.1: Establish knowledge domain for topic 'Network Modelling'</td>
<td>Introduction to Network Modelling</td>
</tr>
<tr>
<td>45~50</td>
<td>FRCl.1: Magnify the intensity of student sadness associated with extra-life topic</td>
<td>Video about poor children</td>
</tr>
</tbody>
</table>
### Implementation and Sample (1)

<table>
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<tr>
<th>Course Design: FRs and DPs</th>
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<tr>
<th>Implementation and Sample</th>
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</table>

| Results and Feedback      |

- **IE200: Introduction to Operation Research (KAIST)**
  - Spring 2013 semester
  - 2\textsuperscript{nd} year course
  - Basic elective open to any major
  - Traditional lecture format
  - 100 students from all majors and years

- **Why?**
  - “Easy” to realize (the authors teach and TA the course)
  - Rapid feedback is possible (1 semester)
  - Many applications of the material
  - May be possible to create a life-changing experience
Now provide an example of a lecture design

Course content of the lecture
- Network models for transportation problems
- Optimization methods to minimize transport cost
- Context of the example is food distribution network

Format of the class
- Introduction: Lecture (5-10 minutes)
- Student actively solve two problems in groups (35 minutes)
- Concluding remarks: Lecture (5 minutes)

A snippet from the concluding remarks follows
Some Perspective (1): Fixed Budgets

- Relief organizations typically work on a fixed budget
  - Funding provided by governments, companies, private donors and NGOs
  - When the money runs out... that’s the end of it!
- As we saw in our beginning Red Cross distribution:
  - There are good ways to distribute supplies and
  - There are worse ways to distribute them
- Fixed budget: Food vs. distribution costs

<table>
<thead>
<tr>
<th>Fixed Budget</th>
<th>Food Costs</th>
<th>Distribution Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expensive distribution</td>
<td>More food delivered!</td>
<td>Optimal distribution</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Relief Cost</th>
<th>Distributio n Costs</th>
<th>Distributio n Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Costs</td>
<td></td>
<td>Food Costs</td>
</tr>
</tbody>
</table>
Some Perspective (3): World of Starvation

• 1/3 of human deaths are due to hunger

• 1.2 billion people live with less than US$ 1 per day

• About 6000 children are dying of starvation EVERY DAY

• Can we help them?
What will you get...
With a degree in engineering...?
Money...?
Success...?
Yes... you can get these things
But...
You can also be a savior...
For them...
Every 15 seconds...
One child...
Dies from hunger
During our class today...
Which studied food distribution...
200 children have died
Not only doctors...
Also engineers...
Can save them.
And...
YOU can do it also.
“Science without conscience is the ruin of the soul”

– Francois Rabelais
Results and Feedback (1)

- What we want to report...
  - Statistical results from anonymous course evaluation survey
  - Positive and negative student comments from anonymous course evaluation survey

- However, we will have the data next week
  - KAIST Spring 2013 semester ended last Friday
  - Course evaluation results are not yet released

- So... what can we report?
Results and Feedback (2)

- Unsolicited e-mail received near the end of the semester
  - Trying to improve this course for many years, but...
  - Never received these kinds of e-mails before
  - This is from 7% of the class

<table>
<thead>
<tr>
<th>EXCERPT</th>
<th>EXCERPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was really glad to learn this course... It was very fun and helpful. I will always remember your saying that engineers should use their gifts for other people. I will try hard to become a good engineer.</td>
<td>I would like to say thank you... I learned a lot of things including external study (engineers humanity). and happy from entertaining Inclass activity (making sandwich, Casino, etc. a lot).</td>
</tr>
<tr>
<td>I want to say thank you. I am really pleased to take [the] class. The lectures were very impressive and interesting. I am really glad but I can’t explain it in English. Thank you very much...</td>
<td>Thank you for this whole semester... I’ve learnt a lots of things from your lectures. One of the best things that I’ve done in this semester is took IE200, Thank you.</td>
</tr>
<tr>
<td>It was my pleasure to attend [the] class ... thank you...</td>
<td>... so impressed! I was very happy that I can participate this class</td>
</tr>
<tr>
<td>I really appreciate ... IE200... It was very honored to learn Operation Research ... :-)</td>
<td></td>
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Concluding Remarks (1)

• Education
  – An essential element of modern society
  – Most efforts have focused on contents and a macroscopic view

• We embarked upon a service-oriented university course design process

• Axiomatic Design methodology
  – Developed CNs based on 10 categories of material
  – Identified FRs and DPs based on 4 categories (Bloom’s taxonomy, learning styles, emotions and senses)

• Redesigned the KAIST IE200 course
  – Used this formal approach to develop new lectures and activities
  – Injected emotional and sensory functions into the course material
  – Implemented the design... early results are encouraging!

• Instructors (course designer) can use the prototype FRs and DPs to help guide course development
Concluding Remarks (2)

- Future directions
  - Statistical analysis of the student course evaluation data
  - Update FRs and DPs with feedback and evaluation
  - Implement the methods for another course and improve the flexibility
  - Further develop the detailed design process for use by others
Concluding Remarks (3)

• Even if one’s lecture content is fantastically clear and complete,

  unmotivated students will not absorb the material...

• So, we investigated a service-oriented approach ...

  towards a future where everyone enjoys learning!
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Thank you!