Integrating Technology into Pre-service Physics Teachers‘ Pedagogical Content Knowledge

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Overview

- Findings from educational research
- Teacher education courses
- Research Questions
- Methods & Samples
- Results
- Conclusions
Purpose of the study

- Develop pre-service physics teachers TPCK
- Test ICTforIST modules in teacher education
- Integrate ICTforIST modules in teacher education courses based on
  - TPCK Framework
  - LoTI Framework
  - Assessment Rubric
  - Constructivist approaches to pedagogy
  - Confronting students’ alternative physics conceptions
Framework for TPCK

(Technology & Pedagogy & Content)

Based on Koehler & Mishra (2008)
Framework for LoTI

(Levels of Technology Implementation)

AWARENESS – Level
EXPLORATION – Level
INFUSION – Level
INTEGRATION – Level
EXPANSION – Level

Based on Moersch (1995)
Course design for future physics teachers

- Blended learning course (embedded into a regular course)
- Preservice physics teachers
- 16 weeks
- Three 4-hour in-class units
- Supported by a Moodle platform

Self – study, share and discuss ideas, individual lesson plans

Three 4 – hour in – class units
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Video analysis with VIAANA
- Free fall
- Accelerated car
- Rebounding trolley
- Motion in 2 dimensions

Designing 3 Lesson Plans for 3 Topics
- Motion and Forces
- Simple Electrics Circuits
- Newton’s Law of Cooling

1. Data logging activities
- Walking motion
- Free fall
- Accelerated trolley
- Rebounding trolley

2. Modelling with VENSIM
- Free fall
- Accelerated trolley
- Rebounding trolley
- Newton’s Law of cooling

3. Simulation
- Terminal velocity
- Mass on a spring
- Rebounding trolley
- Electric circuits

Research Findings | Training Courses | Research Questions | Methods & Samples | Results | Conclusions
Research Questions

RQ 1: Is there a relationship between motivational orientations and the self-reported evolution of TPCK?

RQ 2: Are self-reported knowledge gains in TPCK in agreement with external assessment of lesson plan designs?
Methods and Samples

- 17 prospective physics teachers (9♀, 8♂)
- Four different types of Educational Technology
  - Data Logging
  - Video measurement
  - Simulations
  - Modelling
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Resources

- Electricity Concepts and Circuits

- Motion and Forces

- Data logging

- Video measurement

Simulation

- Modelling

- Video measurement
Instruments

- **MSLQ** Inventory (adapted from Pintrich et al., 1992)
- **TPCK** Inventory (adapted from Schmidt et al., 2009)
- **TIAR** Technology Integration Assessment Assessment Rubric (Harris et al., 2010)
- **RJ** Reflection Journals

Research Findings | Training Courses | Research Questions | Methods & Samples | Results | Conclusions
5 Scales from MSLQ Inventory

- Intrinsic Goal Orientation (4 Items)
- Extrinsic Goal Orientation (4 Items)
- Task Value (6 Items)
- Control of Learning Beliefs (4 Items)
- Self-Efficacy for Learning & Performance (8 Items)
## 5 Items from TPCK Inventory

<table>
<thead>
<tr>
<th>TPCK</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPCK1</td>
<td>I can use strategies that combine content, technologies and teaching approaches that I learned about in my lesson plans.</td>
</tr>
<tr>
<td>TPCK2</td>
<td>I can design lessons that appropriately combine physics, technologies and teaching approaches.</td>
</tr>
<tr>
<td>TPCK3</td>
<td>I can choose technologies that enhance the content for a lesson.</td>
</tr>
<tr>
<td>TPCK4</td>
<td>I can select technologies to use in my lesson plans that enhance what I teach, how I teach and what students learn.</td>
</tr>
<tr>
<td>TPCK5</td>
<td>I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches.</td>
</tr>
</tbody>
</table>
## Technology Integration Assessment Rubric

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Awareness</th>
<th>Exploration</th>
<th>Infusion</th>
<th>Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum Goals (CG)</td>
<td>Technologies are <strong>not aligned</strong> with CG</td>
<td><strong>... partially aligned</strong> with CG</td>
<td><strong>... aligned</strong> with CG</td>
<td><strong>... strongly aligned</strong> with CG</td>
</tr>
<tr>
<td>Instructional Strategies (IS)</td>
<td>Technology use <strong>does not support</strong> IS</td>
<td><strong>... minimally supports</strong> IS</td>
<td><strong>... supports</strong> IS</td>
<td><strong>... optimally supports</strong> IS</td>
</tr>
<tr>
<td>Technology Selections (TS)</td>
<td>TS are inappropriate given CG &amp; IS</td>
<td><strong>... marginally appropriate</strong></td>
<td><strong>... appropriate, but not exemplary</strong></td>
<td><strong>... exemplary</strong></td>
</tr>
<tr>
<td>„Fit“ TPCK</td>
<td>Content, IS and Technology <strong>do not fit together</strong></td>
<td><strong>... fit together somewhat</strong></td>
<td><strong>... fit together</strong></td>
<td><strong>... fit together strongly</strong></td>
</tr>
</tbody>
</table>

Based on LoTi Framework (Moersch, 1994) & TIAR (Harris et al., 2010)
Results

Motivational Orientations (Cluster analysis)

- CL1 (n = 5)
- CL2 (n = 4)
- CL3 (n = 8)
Self-reported
Evolution of TPCK

**TEST OF HOMOGENEITY OF VARIANCES**

<table>
<thead>
<tr>
<th>Mean Level of TPCK evolution</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.023</td>
<td>2</td>
<td>14</td>
<td>.169</td>
</tr>
</tbody>
</table>

**ONEWAY ANOVA**

<table>
<thead>
<tr>
<th>Mean Level of TPCK evolution</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>160.809</td>
<td>2</td>
<td>80.404</td>
<td>10.399</td>
<td>.002</td>
</tr>
<tr>
<td>Within Groups</td>
<td>108.250</td>
<td>14</td>
<td>7.732</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>269.059</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Quality of Lesson Plans

**TEST OF HOMOGENEITY OF VARIANCES**

<table>
<thead>
<tr>
<th>Mean Level of quality of lesson plans</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.921</td>
<td>2</td>
<td>14</td>
<td>.183</td>
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</tbody>
</table>

**ONEWAY ANOVA**

<table>
<thead>
<tr>
<th>Mean Level of quality of lesson plans</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>602.325</td>
<td>2</td>
<td>301.163</td>
<td>9.015</td>
<td>.003</td>
</tr>
<tr>
<td>Within Groups</td>
<td>467.675</td>
<td>14</td>
<td>33.405</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1070.000</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graph showing the comparison of lesson plans between groups CL1, CL2, and CL3, with quality levels on a scale from 0 to 16.
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**Model Summary**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R-Square</th>
<th>Adjusted R-Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.725</td>
<td>.526</td>
<td>.494</td>
<td>5.817</td>
</tr>
</tbody>
</table>

Predictors: (Constant), Self-reported evolution of TPCK

**ANOVA**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>562.409</td>
<td>1</td>
<td>562.409</td>
<td>16.620</td>
<td>.001^a</td>
</tr>
<tr>
<td>Residual</td>
<td>507.591</td>
<td>15</td>
<td>33.839</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1070.000</td>
<td>16</td>
<td>33.839</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^a Predictors: (Constant), Self-reported evolution of TPCK

**Research Questions**

**Methods & Samples**

**Results**

**Conclusions**

**COEFFICIENTS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>14.985</td>
<td>2.623</td>
<td>5.713</td>
<td>.000</td>
</tr>
<tr>
<td>TPCK evolution</td>
<td>1.446</td>
<td>.355</td>
<td>.725</td>
<td>.001</td>
</tr>
</tbody>
</table>

Dependent variable: Self-reported evolution of TPCK
Summary

- Goals and value beliefs for the course have a positive impact on the self-reported evolution of TPCK.
- Self-reported knowledge gains in TPCK are in agreement with external assessment of lesson plan designs.
- Course materials and the design of the course stimulate teachers to think about useful technology integration.
- Prospective teachers are looking forward to implement their lesson plans in their future classrooms.
Conclusions & Implications

- ICTforIST modules seem to be effective for motivating preservice physics teachers to engage in technology integration.

- Courses have to be designed carefully to meet the needs of future teachers in teaching physics with technology.

- Challenge to involve technology in the preservice teachers‘ practices.
Thank you for your attention!

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