Toward learning analytics for instructional design
Case of Learning Analytics Practice in High School

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Evidence-based Instructional Design Cycle

Instructional Design
Collecting data
Feedback and modeling
Learning Analytics
Evaluation design
Implementation
Instruction

Reconsideration of ID

Traditional ID
A
D
D
I

Course starts

Course ends

LA-based ID

1. How should we form the support system?
2. How does LA change teacher’s teaching belief?
3. How do LA and other support system support teachers’ decision making about instructional design?
Preliminary case study

- Learners: 80 students of 10-grade students (High school)
- 6 weeks (classes using learning analytics platform started on Jun. 3)
- 1 class = 50 min
- Subjects: Mathematics and English
  - Mathematics: one class everyday
    - 80 students were divided into three groups according to entrance examination score
    - Three teachers teach mathematics in different class
  - Same textbook, same test
- English: 2 classes / week
  - One teacher teaches English in both classes
- Device
  - iPad provided by school and smartphone of their own
  - Not permit to bring iPad to their home
- Dispatch educational design assistants (every class in the first period)

Preparation/Pilot study

Creation of system manual
System lecture
Implementation of trial classes
Permission to use educational and learning data
Ethical judgment by both local government and universities

Implementation

Understanding the teaching characteristics of teachers
Class and intervention design with LA platform

Evaluation

Evaluation with various granularities
Each evaluation is integrated
Feedback

Suggestion for Class design improvement based on LA and learning theories
System improvement

Systems

Moodle
BookRoll (eBook viewer)
Dashboard

Procedure

Preparation/Pilot study

Implementation

2019.Aug
Workshop

Evaluation

Reflection & Meeting

2019/10/11
Teaching experience and their teaching belief

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mathematics</th>
<th>Mathematics</th>
<th>Mathematics</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience</td>
<td>25 years</td>
<td>30 years</td>
<td>8 years</td>
<td>4 years</td>
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</tbody>
</table>

Teaching style

- **Teacher A**: Mainly using textbooks, solving questions during class, and answering students’ questions.
- **Teacher B**: Also using textbooks, solving questions during class, and asking students to respond.
- **Teacher C**: Mainly using textbooks, asking questions during class, and answering students’ questions.
- **Teacher D**: Also using textbooks, asking questions during class, and answering students’ questions.

System usage

- **Teacher A**: No attempts to use the system;
- **Teacher B**: Attempted to use the system;
- **Teacher C**: Attempted to use the system;
- **Teacher D**: Attempted to use the system.

Basic instructional design (learning behavior level)

1. Teachers asked learners to add markers (yellow: difficult, red: important) and memo on e-textbook.
2. Teachers confirmed the difficult parts (yellow marker) on e-textbook using dashboard.
3. Teachers started their class:
   - Teachers taught the subject.
   - Teachers asked learners to delete marker(s), when they understood the difficult parts by class.
4. Back to 1st.

Educational Design Assistant (EDA)

1. Lecture about three system to teachers.
2. Create system manuals.
3. Respond to questions about system usage from teachers and students.
4. Handling of problems during classes using the system. If a system problem is discovered, take it back to the university and keep in touch with the system developer.
5. Suggest about instructional design based on the dashboard and learning analytics data.

We required teachers to follow this ID first.

Teachers can change instructional design if they want to re-design their instruction.

We asked learners to delete markers, when they understood the difficult parts by class.

Back to 1st.
Educational Design Assistant (EDA)

Roles
1. Lecture about three system to teachers
2. Create system manuals
3. Respond to questions about system usage from teachers and students
4. Handling of problems during classes using the system. If a system problem is discovered, take it back to the university and keep in touch with the system developer
5. Suggest about instructional design based on the dashboard and learning analytics data

Have a meeting after every class for 4 and 5. EDAs report about lectures, problems, actions, and requirement from teachers

Collected data
- BookRoll logs (113,768 records in 6 weeks)
- Test score (pre- and post tests)
  - Original test of this school
  - Pre test score was used for grouping of proficiency
- Course Interest Survey (CIS) (Keller, 2009) *under analysis
  - Investigating the perception of ID (ARCS model)
  - 4 factors, 34 items in sum
  - We asked the learners to answer it at the last class in the first period (Jul. 18, 2019)

Results: Week 1

<table>
<thead>
<tr>
<th>Class</th>
<th>ID</th>
<th>ID2</th>
<th>ID3</th>
<th>ID4</th>
<th>ID5</th>
<th>ID6</th>
<th>ID7</th>
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<td>Class A</td>
<td>103</td>
<td>104</td>
<td>105</td>
<td>106</td>
<td>107</td>
<td>108</td>
<td>109</td>
</tr>
<tr>
<td>Class B</td>
<td>110</td>
<td>111</td>
<td>112</td>
<td>113</td>
<td>114</td>
<td>115</td>
<td>116</td>
</tr>
<tr>
<td>Class C</td>
<td>117</td>
<td>118</td>
<td>119</td>
<td>120</td>
<td>121</td>
<td>122</td>
<td>123</td>
</tr>
<tr>
<td>Class D</td>
<td>124</td>
<td>125</td>
<td>126</td>
<td>127</td>
<td>128</td>
<td>129</td>
<td>130</td>
</tr>
<tr>
<td>Class E</td>
<td>131</td>
<td>132</td>
<td>133</td>
<td>134</td>
<td>135</td>
<td>136</td>
<td>137</td>
</tr>
<tr>
<td>Class F</td>
<td>138</td>
<td>139</td>
<td>140</td>
<td>141</td>
<td>142</td>
<td>143</td>
<td>144</td>
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</table>

Video
### Results: Week 3

<table>
<thead>
<tr>
<th>Test Score</th>
<th>Class A</th>
<th>Class B</th>
<th>Class C</th>
<th>Class D</th>
<th>Class E</th>
<th>Class F</th>
<th>Class G</th>
<th>Class H</th>
<th>Class I</th>
<th>Class J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math A</td>
<td>37.60 (14.77)</td>
<td>47.10 (14.84)</td>
<td>55.83 (8.73)</td>
<td>F(2,29) = 2.327</td>
<td>p = 0.115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math B</td>
<td>45.71 (19.47)</td>
<td>31.38 (12.55)</td>
<td>55.89 (10.61)</td>
<td>F(2,21) = 6.272</td>
<td>p = 0.007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math C</td>
<td>22.50 (3.536)</td>
<td>50.54 (11.362)</td>
<td>57.67 (13.64)</td>
<td>F(2,21) = 6.978</td>
<td>p = 0.005</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>English</td>
<td>55.00 (12.73)</td>
<td>62.65 (9.57)</td>
<td>75.69 (9.32)</td>
<td>F(2,77) = 11.451</td>
<td>p = 0.001</td>
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### Results: Week 5

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<th>Test Score</th>
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<th>Class D</th>
<th>Class E</th>
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<th>Class I</th>
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### Reflection for learning analytics and system

- Not only teachers but also head of school and municipal board of education (policy makers) attended this workshop
- Feedback from teachers to researchers
  - How to understand data analytics results for the improvement of class design
  - System modification
- Feedback from policy makers to head of school and researchers
  - Analyzing the data for the enhancement of learning performance
  - Evidence for the improvement of the network and ICT environments
- Feedback from head of school to researchers
  - Improving teaching skills for novice teachers using dashboard and other ICT

### Learning Performance

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
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<tbody>
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<td>Mathematics A</td>
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<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Post-hoc (Scheffe)</th>
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<td>Mathematics A</td>
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- H > M, p < 0.01
- M > L, p < 0.05
- H > L, p < 0.01
- H > M, p < 0.001
- H > L, p < 0.001
Correlation analysis (between BookRoll logs and post test)

<table>
<thead>
<tr>
<th></th>
<th>BookRoll</th>
<th>Marker (Yellow)</th>
<th>Marker (Red)</th>
<th>Memo</th>
<th>BookRoll K</th>
<th>Mark</th>
<th>Memo</th>
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<td>-0.04</td>
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<tr>
<td>Math B</td>
<td>-0.32</td>
<td>-0.34</td>
<td>-0.19</td>
<td>-0.36†</td>
<td>-0.04</td>
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<td>-0.28</td>
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<tr>
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<td>0.25</td>
<td>0.35</td>
<td>-0.06</td>
<td>0.07</td>
<td>-0.05</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>0.06</td>
<td>0.17</td>
<td>0.00</td>
<td>0.08</td>
<td>-</td>
<td>-0.42*</td>
<td>-0.05</td>
<td>-0.22</td>
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<tr>
<td>English</td>
<td>-0.19</td>
<td>-0.07</td>
<td>-0.13</td>
<td>0.05</td>
<td>0.02</td>
<td>-0.28</td>
<td>-0.18</td>
<td>0.03</td>
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<td>-0.28†</td>
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<tr>
<td>English</td>
<td>-0.11</td>
<td>0.09</td>
<td>0.09</td>
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<td>-0.13</td>
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<tr>
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<td>-0.12</td>
<td>0.01</td>
<td>0.23</td>
<td>0.18</td>
<td>-0.23</td>
</tr>
</tbody>
</table>

Upper: in-class, lower: out-of-class, *: p < 0.05. † p < 0.1

Interview with teachers (part of their answer)

• Teacher A (Mathematics)
  • He did not use these systems after week 3, because many students failed to access BookRoll, and he wanted learners to focus on post test (repeat to engaged in drill and practice)

• Teacher B (Mathematics)
  • He wanted to understand the usage of these system and effects of learning analytics. He anyway continued to use these system for class design

• Teacher C (Mathematics)
  • He did not use these system too much. He believes that hand-writing is very important learning behavior. These system had limited functions for hand-writing. He prefers to use Moodle. He required the students to submit photo of note(paper).

• Teacher D (English)
  • He wanted to understand the usage of these system and effects of learning analytics(the same idea as teacher B). But e-Textbook is very easy. I created original learning materials at the end of the first period

Future works

• Analyze learning behavior patterns of both low and higher performers
• Interview with stakeholders including policy makers, showing the results
• Collect the data from various viewpoints such as ID, intervention, their effects, stakeholders
• Set in-service lectures about LA-based ID for the support of their decision-making
  • How to use educational data, and ID tips based on the dashboard
Thank you very much

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