Investigating the Effect of Taking and Reviewing the Annotations and Homework to Math Learning

CAITER 2009

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Content

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Introduction

• Annotations represent students’ understanding of learning material
• Annotations are useful in the process of study, especially on developing of metacognitive skills and promoting comprehension of learning material (David and Dale, 2005, Grabinger, 1996, Oscarson, 1989)
• Insufficient attention on the effects of reviewing of own notes as annotations or homework solutions and consultation to the annotations and homework solutions of other students:
  – What will happen when students return to their notes to review them or to consult others’ notes?
  – What are their influence on learning achievement?
  – What is the difference between reviewing own notes or consulting others’?
Related work: Web annotation systems

- Fluid Annotation
- Screen Crayons
- Annotea
- Amaya
- WISPA (the Web Indicator by Sharing Personal Annotations)
- CAML (Context-based free-form Annotation Markup Language)
- The most common limitations of the systems:
  a) lack of support annotations to multimedia objects;
  b) lack of support multimedia annotations, including content like pictures, graphs, audio and etc.;
  c) lack of support annotations for collaboration and sharing;
  d) lack of interactive and manageable mechanism for annotation, the mechanism to control annotations access by other users, this allows annotations taken and edited by several students.
Related work: Influence of annotations on learning achievement

• 1) adding notes; 2) summarizing; 3) posing questions and 4) highlighting are the methods as metacognitive strategy (McMahon and Oliver, 2003) which can be supported by annotation tools

• Annotation can promote students’ metacognitive skills and reading comprehension (David and Dale, 2005)

• Annotation of thinking and “self conversation” is one metacognitive strategy (Grabinger, 1996)

• Taking note can support self-evaluation in the metacognition (Oscarson, 1989)
Related work: Influence of annotations on learning achievement

• An annotation system to assist individual and collaborative learning and investigation of the impact on learning motivation and learning achievement (Hwang and Wang, 2004)

• Three categories of annotations: mark annotation, text annotation and picture annotation (Pan, 2006)
Related work: Influence of annotations on learning achievement

• Benefit from reviewing annotations in learning from lectures (Kiewra, 1985) and in text comprehension (Kardash & Kroeker, 1989)
• Significant review and process effects in spontaneous note-taking (Slotte and Lonka, 1999)
• Advantages of annotations that allow the informal sharing of knowledge related to an artifact or concept (Hicks, 2003 and Onas-Kukkonen, 1997)
• Shared annotations as a trigger to start discussions about a topic in a collaborative learning environment (Kappe & Maurer, 1994, Koivunen & Swick, 2001)
Related work: Math Problem Solving with Metacognition and Self-reflection

• The procedure of Math problem solving as following four steps: 1) understanding the problem; 2) devising a plan; 3) carrying out the plan and 4) looking back (Polya, 1945)

• Reminding students to pay much attention to re-examine the computational process and check the answer can increase the accuracy of Math problem solving (Garofalo and Lester, 1985)

• The process of devising a plan, choosing a goal and examining the problem solving process is very strongly related to metacognition (Schoenfeld, 1985)
Related work: Math Problem Solving with Metacognition and Self-reflection

• Metacognition recognized the value of self-reflection in enhancing students’ ability to monitor, assess and improve their performance and thinking (Branch, Grafelman & Hurelbrink, 1998 and Reiman & Thies-Sprinthall, 1998)

• Reflection is useful for understanding mathematics and we somehow moved into another dimension when we reflected on what we have done (Dubinsky, 1991)

• Self-reflection as a tool for challenging and clarifying thinking (Joseph N., 2003)
Research design: Objectives

• The participants: 34 first grade students in one junior high school
• Experiment were carried out in computer classroom during one hour per week for one semester (4 months)
• The topic of Math learning materials was related to “Linear equation with two variables“
• The learning materials were available for the students from e-learning platform with the VPen system
• The students used personal account and password to login the web based learning system
Research design: Research variables

• The independent variables:
  – the amount of the annotations taken
  – the amount of the reviewed text annotations
  – the frequency of reviewed text annotations
  – the amount of the consultations to others’ annotations
  – the amount of the homework solutions
  – the amount of the homework solutions reviewed
  – the frequency of reviewed homework solutions
  – the amount of the consultations to others’ homework solutions
Research design: Research variables

• The dependent variable:
  – learning achievement which is measured by the score of the post test
Research design: The web annotation system

• A list of the functionalities to design:
  a) annotating with freestyle mark
  b) taking and moving the annotations on any positions of web page
  c) adding textual comments and inserting multimedia content into annotation
  d) supporting annotating of the multimedia objects
  e) annotation sharing and displaying at the same time
  f) annotation access control
Research design: The web annotation system

• The web annotation system VPen allows:
  a) to mark annotations as highlight, underline marks and special symbols as asterisk, bracket, circles and round rectangle, in addition, the VPen system supports arbitrary position of putting annotations;
  b) to annotate various objects on the web, both text and images;
  c) to have rich and various content of the annotations, i.e. include text, table, image and audio;
  d) to share annotations with other students;
  e) to have interactivity and management of annotations support to setup the access right of annotations as private, group or public and allow other students to access them.
Research design: The web annotation system

Interface of VPen system
Research design: The web annotation system

The Annotation Toolbar

- To highlight the text
- To underline the text
- To draw a geometric figure
Research design: The web annotation system

Example of geometric figures and there are text annotations besides
Research design: The web annotation system

Example of homework solutions
Research design: The web annotation system

Annotation to multimedia object with multimedia content
Research design: The web annotation system

The Html Area function of Comment box
Research design: The web annotation system

The Access Control of annotation
Research design: The web annotation system

The interface of (a) the personal homework solution review and (b) consultation other’s homework solution.
Research design: Experimental procedure

• the students studied the learning material in each unit and took the annotations on the content;
• the students completed the homework of the unit;
• the students reviewed their own annotations and homework solutions;
• the students shared the annotations and homework solutions with other students and consulted to others’ annotations and homework solutions.
Data analysis and results

• How annotation and homework influence students learning achievement respectively

• Comparison of the influence of those two products on learning and find which product will have more impact on learning achievement

• Investigation the reasons why there are such differences based on their characteristics
Data analysis and results: The statistics analysis of annotations

• The correlation analysis
  – The statistical data of our experiment has included:
    • the amount of mark annotations taken,
    • the amount of text annotations taken,
    • the amount of annotations reviewed,
    • the frequency of annotations reviewed and
    • the amount of consultations of students to others’ annotations
  – The relationships among the variables analyzed using Pearson Correlation and their effect on learning achievement of students
Data analysis and results: The statistics analysis of annotations

<table>
<thead>
<tr>
<th></th>
<th>Learning achievement</th>
<th>Mark annotations taken</th>
<th>Text annotations taken</th>
<th>Annotatıons reviewed</th>
<th>Frequentıty of annotations reviewed</th>
<th>Consultatıons to others’ annotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning achievement</td>
<td>1</td>
<td>.290</td>
<td>.654(**)</td>
<td>.688(**)</td>
<td>.591(**)</td>
<td>.039</td>
</tr>
<tr>
<td>Mark annotations taken</td>
<td>.290</td>
<td>1</td>
<td>.454(**)</td>
<td>.306</td>
<td>.193</td>
<td>.049</td>
</tr>
<tr>
<td>Text annotations taken</td>
<td>.654(**)</td>
<td>.454(**)</td>
<td>1</td>
<td>.933(**)</td>
<td>.477(**)</td>
<td>-.178</td>
</tr>
<tr>
<td>Annotatıons reviewed</td>
<td>.688(**)</td>
<td>.306</td>
<td>.933(**)</td>
<td>1</td>
<td>.640(**)</td>
<td>-.193</td>
</tr>
<tr>
<td>Frequency of annotations reviewed</td>
<td>.591(**)</td>
<td>.193</td>
<td>.477(**)</td>
<td>.640(**)</td>
<td>1</td>
<td>.111</td>
</tr>
<tr>
<td>Consultatıons to others’ annotations</td>
<td>.039</td>
<td>.049</td>
<td>-.178</td>
<td>-.193</td>
<td>.111</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1. The correlation analysis of all statistics quantity of annotations and learning achievement

** - significant positive, * - significant
Data analysis and results: The statistics analysis of annotations

• Results:
  – The amount of mark annotations taken has no significant correlation with learning achievement of students (0.290)
  – The amount of text annotations taken has significant positive correlation with learning achievement of students (0.654**)
  – The amount of annotations reviewed has significant positive correlation with learning achievement of students (0.688**)
  – The amount of the annotations reviewed has significantly positive correlation with the amount of text annotations taken (0.933**)
  – The frequency of the annotations reviewed has significant positive correlation with learning achievement of students (0.591**)
  – The amount of consultations of students to others’ annotations has very low correlation with learning achievement of students (0.039)
Data analysis and results: The difference of HA group and LA group with annotations

<table>
<thead>
<tr>
<th></th>
<th>Students achievements</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark annotations taken</td>
<td>High</td>
<td>71.78</td>
<td>51.371</td>
<td>1.365</td>
<td>.191</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>42.44</td>
<td>38.927</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Text annotations taken</td>
<td>High</td>
<td>31.11</td>
<td>24.210</td>
<td>3.623</td>
<td>.006</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>1.67</td>
<td>2.872</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annotations reviewed</td>
<td>High</td>
<td>39.33</td>
<td>25.441</td>
<td>4.448</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>1.22</td>
<td>3.667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of annotations</td>
<td>High</td>
<td>1.421796</td>
<td>.4204662</td>
<td>6.590</td>
<td>.000</td>
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<tr>
<td>reviewed</td>
<td>Low</td>
<td>.135802</td>
<td>.4074074</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultations to others’</td>
<td>High</td>
<td>5.56</td>
<td>3.972</td>
<td>-.259</td>
<td>.799</td>
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<tr>
<td>annotations</td>
<td>Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 2. The difference of high and low achievement groups on all statistics quantity of annotations*
Data analysis and results: The difference of HA group and LA group with annotations

• Results:
  – There is no significant difference between high and low achievement groups of students on the amount of mark annotations taken
  – There is significant difference between high and low achievement groups of students on the amount of text annotations taken
  – There is significant difference between high and low achievement groups of students on the amount of annotations reviewed
  – There is significant difference between high and low achievement groups of students on the frequency of annotation reviewed
  – On the amount of consultations to others’ annotations there is no significant difference between high and low achievement groups of students but there is interesting phenomena, low achievement students perform better than high achievement students in this variable
Data analysis and results: The statistics analysis of homework

• The correlation analysis
  – The statistical data of our experiment has included:
    • the amount of homework solutions,
    • the amount of homework solutions reviewed,
    • the frequency of homework solutions reviewed and
    • the amount of consultations to others’ homework solutions
  – The relationships among the variables analyzed using Pearson Correlation and their effect on learning achievement of students
Data analysis and results: The statistics analysis of homework

<table>
<thead>
<tr>
<th></th>
<th>Learning achievement</th>
<th>Homework solutions</th>
<th>Homework solutions reviewed</th>
<th>Frequency of homework solutions reviewed</th>
<th>Consultations to others’ homework solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning achievement</td>
<td>1</td>
<td>.631(**)</td>
<td>.616(**)</td>
<td>.393(*)</td>
<td>-.299</td>
</tr>
<tr>
<td>Homework solutions</td>
<td>.631(**)</td>
<td>1</td>
<td>.680(**)</td>
<td>.312</td>
<td>.126</td>
</tr>
<tr>
<td>Homework solutions reviewed</td>
<td>.616(**)</td>
<td>.680(**)</td>
<td>1</td>
<td>.878(**)</td>
<td>-.113</td>
</tr>
<tr>
<td>Frequency of homework</td>
<td>.393(*)</td>
<td>.312</td>
<td>.878(**)</td>
<td>1</td>
<td>-.184</td>
</tr>
<tr>
<td>solutions reviewed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultations to others’</td>
<td>-.299</td>
<td>.126</td>
<td>-.113</td>
<td>-.184</td>
<td>1</td>
</tr>
<tr>
<td>homework solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. The correlation analysis of all statistics quantity of homework and learning achievement

** - significant positive, * - significant
Data analysis and results: The statistics analysis of homework

• Results:
  – The amount of homework solutions has significantly positive correlation with learning achievement of students (0.631**)
  – The amount of homework solutions reviews has significantly positive correlation with the amount of homework solutions (0.680**)
  – The amount of homework solutions reviews has significant positive correlation with learning achievement (0.616**)
  – The frequency of homework solutions reviewed has significant correlation with learning achievement (0.393**)
  – The amount of consultations to others’ homework solutions has weak inverse correlation with learning achievement (-0.299)
Data analysis and results: The difference of HA group and LA group about homework

<table>
<thead>
<tr>
<th>Students achievements</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework solutions</td>
<td>High</td>
<td>49.67</td>
<td>8.818</td>
<td>3.669</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>25.22</td>
<td>17.936</td>
<td></td>
</tr>
<tr>
<td>Homework solutions reviewed</td>
<td>High</td>
<td>76.67</td>
<td>31.839</td>
<td>3.910</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>26.11</td>
<td>22.150</td>
<td></td>
</tr>
<tr>
<td>Frequency of homework solutions reviewed</td>
<td>High</td>
<td>1.551618</td>
<td>.6532924</td>
<td>2.189</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>.973778</td>
<td>.4474469</td>
<td></td>
</tr>
<tr>
<td>Consultations to others’ homework solutions</td>
<td>High</td>
<td>4.89</td>
<td>3.333</td>
<td>-1.936</td>
</tr>
</tbody>
</table>

Table 4. The difference of high and low achievement groups on all statistics quantity of homework
Data analysis and results: The difference of HA group and LA group about homework

• Results:
  – There is significant difference between high and low achievement groups on the amount of the homework solutions
  – There is significant difference between high and low achievement groups on the amount of homework solutions reviewed
  – There is significant difference between high and low achievement groups on the frequency of homework solutions reviews
  – On the amount of consultations to others’ homework there is no significant difference between high and low achievement groups of students but there is interesting phenomena, low achievement students have more consultations to others’ homework than high achievement students in this variable.
Data analysis and results: The comparison of influence of annotation and homework on learning achievement

• Results:
  – The amount of taken annotations was more beneficial to learning achievement than the amount of homework solutions
  – The amount of reviewed annotations was more beneficial to learning achievement than the amount of reviewed homework solutions
  – Frequency of reviewed annotations was more beneficial to learning achievement than frequency of reviewed homework solutions
Conclusions

• The amount of taken annotations and the amount of homework solutions have significant influence to learning achievement
• The amount of reviewed annotations and homework has significant influence to learning achievement
• The amount of reviewed annotations was found more helpful to learning achievement than the amount of reviewed homework solutions
• The frequency of reviewed annotations or homework solutions has significant influence to learning achievement
• The amount of the consultations to others’ annotations has less influence to learning achievement
• The amount of the consultations to others’ homework solutions has weak inverse correlation with learning achievement
Suggestions

• To improve the mechanism of using asterisk button on the upper right side of annotation frame to count the amount of annotation or homework reviews by recording the time of annotation reviews

• To analyze what kind of students was consulted mostly and analyze their characteristics, so we can find their social relationship and why their works are preferable for consultations

• To improve the design of learning activity by encouraging students to think about new solutions and add more annotations by giving some reward or bonus