A Case Study of the Effect of Online Content Difficulty in Collaborative Learning Communities in College Education

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Abstract: Web 2.0 has made contents readily available especially for learners in higher education. However the quality of these contents has remained a debate among stakeholders. This paper uses action research and content analysis approaches to investigate how the content difficulties affect the collaborative learning among experienced, average and novice learners in an online community. And to construct content with comfort-level to sustain learners’ participation a content difficulty demystification process was used. An experiment was conducted with four groups each with all learner types. Results show that learning difficulty due to the number of difficulty items in a given content is directly proportional to the average time taken for learning, and is inversely proportional to average knowledge score until a point of diminishing content quality. Both before and beyond this point effective collaborative learning and knowledge construction are not sustainable.

Introduction

The current advancement of Internet technology, such as web 2.0, has enabled the implementation of social constructivism to encourage college learners to learn as a community to support each other through participation. This has enabled a new learning paradigm in which these learners have become “knowledge able”-creating and sharing their own knowledge through collaboration among themselves and with their instructor as a facilitator. Some community systems have been proposed to facilitate such online learning community activities (Miettinen et al, 2003, Vassileva, 2008). In such systems, learners scout the Internet for related contents. They can create, download and publish their own content for the community’s benefit. Content here refers to the text, graphics, video, and audio that make up an interactive experience (Halvorson, 2010). Learners can also annotate content difficulties or keywords for future reference or for synchronous or asynchronous collaboration with peers. One of the major challenges of such environments is the question of content quality and relevance of the contents that learners published in their community domain to the educational curriculum (Barbara et al, 2005). Additionally, access to that information can be costly in terms of the difficulty a novice learner faces in accessing the right information within the domain, especially where there is information overload (Vassileva, 2008). Typically, in a college class there are advanced (i.e. stronger) and inexperienced (i.e. weaker) learners (Bannert, 2000, Mokhtari et al, 2002), and average learners who fall between the two learners. The success of these learners, in their community, will depend on the available knowledge and their collaborative activities (Yang, 2006). And to sustain their online learning all the learners have to remain active (Starr et al, 1994). In that situation the learners can learn through self-regulation (Pintrich, 1995) or collaborate with peers when content difficulties occur (Tian et al, 2006). These content difficulties are either created by the knowledge expert or by peers, and can be categorized into “knowledge stimulus” and “knowledge noise”. The knowledge stimulus includes new keywords, new diagrams, new theories, new methods, new models, etc that is part of the intended knowledge. The knowledge noise includes spelling mistakes, grammatical errors, wrong diagrams, ambiguities, off-topic or “unnecessary” information that disrupts learning or increases learners’ cognitive load. Either case can cause a weaker learner to drop out if there is no adequate human assistance through collaborative learning. In collaborative learning, learners interact to bargain constructively to expose new ideas, experiences, deeper understanding, evaluation, new facts and theories (Schellens et al, 2005), which can be stored as community
knowledge capital for future use. Therefore this paper uses action research and content analyses approaches to investigate how the content difficulties affect the collaborative learning activities in terms of time and knowledge construction among these three types of learners (i.e. stronger, average and weaker). Additionally a “content difficulty demystification process” was used to enable construction of content with a comfort-level by the collaborative effort of both the learners and their instructor to sustain the collaborative engagement of all the learners.

**Theoretical Background**

Literature has shown that online individual learning can easily lead to drop out. Therefore with the current power of Internet technology, emphases have been placed on social constructivism (Stahl 2006), shifting between pair learning and community learning. The notion of community learning has been supported by a fertile contribution of ethnographic research applied to the organizational behaviour. Based on the theories of Vygotsky and Piaget, learning has been found to be essentially social (Ravenscroft, 2008, Jones et al, 2005).

The learner as a member of a community participates in actual practice and, as such, gradually learns how to think and act as a community member (Lave et al, 1991). Wenger (1998), suggested that learning occurs through active participation in the practices of communities, while at the same time identities are constructed in relation to these communities. Communities contribute to social learning as they provide the most suitable setting for learning to take shape by providing a suitable non-hierarchical, informal and flexible surrounding that is considered to be a fruitful breeding ground for learning. The activities in such a flexible environment promotes learners’ mental functioning in the creation of ideas, sharing experiences and evaluating acquired knowledge and processes through higher order thinking. Literature however has shown that not all learners engage actively in their collaborative learning. This tendency can be attributed to inadequate communication in the group (Heinze et al, 2006, Farouck et al, 2007), knowledge gap and learning styles (Brindley et al, 2009), or personality and environmental factors (Cheng et al, 2005, Farouck et al, 2010). This paper rather focuses on the effect of the content difficulty irrespective of the learner types that constitute a learning community. In particular,

1. How do the content difficulties affect engagement among the weaker, average and stronger learners in their community?
2. How do the content difficulties cause drop out among these learners during collaborative learning?
3. How do the content difficulties affect the learning time and knowledge construction in the collaborative learning?
4. Can collaborative effort to refine the contents prevent drop out from the collaborative group?

**Research Method**

**Content Difficulty Demystification Process**

In this process the college learners are given initial learning content created by the instructor or knowledge expert with a set goal. Learners can then scout the Internet for further information and interact with both peers and instructor to create their understanding and solve difficulties. This enables the instructor or domain knowledge expert to realize the exact difficulties (or problems) associated with the contents available to learners. The expert can then revise the contents with the group generated knowledge to create a comfort level content that meets the learners’ level of understanding. This refinement can include the addition of some resourceful information from the websites that have been used by some learners, precise definitions that meet learners’ level of understanding, easy to follow approaches to solving some problems, etc. The refined content can then serve as a knowledge capital for the current group and future groups that may utilize them (Fig. 1). This process is based on four theories which include Vygotsky’s Zone of Proximal Development, E-moderation, Content Analysis and Action Research.
Vygotsky’s Zone of Proximal Development

The Zone of Proximal Development (ZPD) according to (Vygotsky, 1978) is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. The ZPD enables learners to have greater learning potentials when in collaboration with more capable peers or instructor who can give assistance when content difficulties occurred. The dialogue that results from such collaboration will reveal some problems and solutions to those problems that can be used to revise the existing content by the knowledge expert.

E-moderation

The e-learning moderation adopted here allows learner-content, learner-peer and learner-instructor interactions to ensure the ZPD (Farouck et al, 2007, Farouck et al, 2010). It has the following stages:
- Key Handling- defines the initial content and the goal of the learning.
- Exploration- allows learners to use their own metacognitive abilities to develop their own mental schema.
- Challenge- defines the stage where learners face difficulties with their learning, and calls for assistance from more capable peers or the instructor. The usual way to do this is to enable learners to annotate the difficulty parts of the content (or the difficulty items) by highlighting or describing them. Any highlighted item is stored with the learner’s ID to enable easy identification of that learner and the exact content difficulty to facilitate collaboration with peers or the instructor.
- Collaboration- enables learners in difficulties to receive assistance from more capable peers in their group, or the instructor through cooperative interaction.

Content Analysis

Content analysis has been defined as a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding (Weber, 1990). The content analysis enables the identification of common problems identified by the learners and the approaches and discussions they used to solve those problems. In turn this enables the instructor to retrieve only relevant information from the pool of contributions to refine the domain content.

Action Research

Action research assists in practical problem-solving and expanding scientific knowledge in an immediate
situation using data feedback in a cyclical process aiming at an increased understanding of a given social situation, primarily applicable for the understanding of change process in social systems and undertaken within a mutually acceptable ethical framework (Hult et al, 1987). The action research enables the learners and their instructor to explore the impact of their learning contents and re-strategize and refine to reflect on the best practices, theories and methodologies (Fig. 2).

**Figure 2: Action Research Model for Content Difficulty Demystification Process**

**Experiment Setup**

In this experiment a total of 12 university students in three categories were used. The categories included four undergraduate students, four masters students and four doctoral students. The assumption was that the doctoral students would act as the stronger learners, the master students would act as the average learners, and the undergraduate students would act as the weaker learners in their groups. Four groups were created with each having three students- one undergraduate student, one master student and one doctoral student. All learners were familiar with computer learning. All groups were given some topics in computer graphics through online, and a chat system for interaction. None of the learners had a background knowledge in computer graphics. Each group was given at most one hour to learn individually. During this learning they were to identify difficulties and write them down even if they could search for the solution from the Internet or other materials. Learners were asked to download all the web content that they had utilized while learning. After the learning activities were completed, the learners were again given up to one hour to collaborate to solve the difficulties that they found. During this time they were again allowed to use any online content or hardcopy materials that could enhance their discussion. After the discussion learners went back to reflect on their understanding and take a test. When the test was over the learners were given a questionnaire to fill out. After every group’s day’s activities the instructor used the rest of the day to prepare the content for the next group. This was done by evaluating the difficulties found, the external materials used, and discussions held by the learners in previous group to demystify the domain contents’ difficulties for the succeeding group. At the end of each learning activities learners were asked to rate the content difficulty through a questionnaire using a Lickert scale. The author also acted as the instructor and the knowledge expert throughout the experiment.

**Experiment Results**

The data used for this presentation came from the learners’ log data, test scores, interview and questionnaire. Table (1) shows the result obtained after the fourth generation (i.e. fourth group of students). The first Group (i.e. Group 1) discovered the highest number of difficulties (problems) while Group 3 and Group 4
identified the least number of problems. It can be seen that the number of problems reduces as generation and time passed by. It can also be seen that from Group 1 to Group 3 the average score was rising and there was a fall for the Group 4. Finally the average time spent by individual learners and by groups shows that both average times reduce as generation passed by.

Table 1: Time and Score Average and Standard Deviation per Group

<table>
<thead>
<tr>
<th>Groups</th>
<th>No of Problems</th>
<th>Score (/100)</th>
<th>Time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Avg (1/100)</td>
<td>Avg (Individual)</td>
</tr>
<tr>
<td>Group 1 (N=3)</td>
<td>9</td>
<td>70</td>
<td>46</td>
</tr>
<tr>
<td>Group 2 (N=3)</td>
<td>3</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>Group 3 (N=3)</td>
<td>2</td>
<td>87</td>
<td>39</td>
</tr>
<tr>
<td>Group 4 (N=3)</td>
<td>2</td>
<td>75</td>
<td>28</td>
</tr>
</tbody>
</table>

Table 2 shows the responses of learners regarding the content difficulty per group from the questionnaire.

Table 2: Content Difficulty Ratings by Individual Learners per Group

<table>
<thead>
<tr>
<th>Groups</th>
<th>Very Difficult</th>
<th>Difficult</th>
<th>Normal</th>
<th>Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (N=3)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Group 2 (N=3)</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Group 3 (N=3)</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Group 4 (N=3)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

A few students also gave some comments. The following comments, in particular, show the perception of some weaker and stronger learners in group 1 and group 4 respectively.

**Comment 1:** Group 1, Weaker learner: “The content was so difficult and I didn’t know what to do. It was also difficult for me to find suitable contents from the Internet for this lesson. When I searched Google with a keyword I found it difficult to select the right information from a whole bunch of stuffs from the search result. I was confused as regards which I should select… I could not participate effectively in the group discussion; I was rather at the receiving end.”

**Comment 2:** Group 4, Stronger learner: “The content was very easy and I didn’t find it challenging at all. Therefore I had to access some contents from the Internet for further reading. Some of the contents I accessed treated the topics more interestingly, though some of them were also difficult to understand.”

These comments revealed some critical information that motivated the analyses of learners’ chat log files (Fig. 3

Table 3: Analysis of Chat Log File of Group 1

<table>
<thead>
<tr>
<th>Learner Type</th>
<th>Questions</th>
<th>Answers</th>
<th>Confirmations</th>
<th>Comments</th>
<th>Total Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>weaker</td>
<td>25%</td>
<td>37.5%</td>
<td>12.5%</td>
<td>25%</td>
<td>8</td>
</tr>
<tr>
<td>average</td>
<td>27.8%</td>
<td>27.8%</td>
<td>22.2%</td>
<td>22.2%</td>
<td>18</td>
</tr>
<tr>
<td>stronger</td>
<td>15.9%</td>
<td>36.8%</td>
<td>10.5%</td>
<td>36.8%</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total Lines</strong></td>
<td><strong>10</strong></td>
<td><strong>15</strong></td>
<td><strong>7</strong></td>
<td><strong>13</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>
Chat Log File of Group 1:

- weaker: hi
- stronger: Hi
- average: Hi
- stronger: About expansion (reduction), if Sx is negative the origin will be the symmetry?
- average: at the state of expansion, if S is negative, it will be reduction, right?
- stronger: equation (23)
- average: from my view...
- stronger: looking equation 2-3, I have a different idea.
- weaker: In case of reflection, it should be fraction-right?
- stronger: if it's reduction we have b=5x-1, well, depends on the purpose of the question.
- average: A fraction or a decimal something like that.
- stronger: i think we can conclude that it is original symmetry.
- weaker: then lets move to the test.
- stronger: yes, let's do the test
- weaker: ok
- stronger: then lets move to the test.

Chat Log File of Group 4:

- weaker: hi
- stronger: Hi
- average: Hi
- stronger: Seems easy.
- average: What is "kew"?
- stronger: Did you mean skew?
- average: Yeah!
- stronger: I think skew means making a parallelogram from a rectangle.
- average: That's very easy to understand.
- stronger: Then, stretch it partially, right?
- weaker: Stretch, then...
- weaker: when we make a synthesis convert, if we change the order of convert the meaning will change too, right?
- average: I don't think that is a question.
- weaker: yeah, that's it.
- average: OK, we can make sure and write down what we understood at the same time.
- weaker: What are T and S in the Matrix equation?
- average: Which equation?
- weaker: Any equation
- average: For example, 2.6
- weaker: yes, that's right.
- average: Please look at chapter 2.6
- stronger: It seems that there is no question anymore.
- average: ok
- weaker: ok
- stronger: then lets move to the test.

Figure 3: Chat Log File of Group 1

- Figure 4: Chat Log File of Group 4

Table 4: Analysis of Chat Log File of Group 4

<table>
<thead>
<tr>
<th>Learner Type</th>
<th>Questions</th>
<th>Answer</th>
<th>Confirmation</th>
<th>Comments</th>
<th>Total Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>weaker</td>
<td>12.5%</td>
<td>0%</td>
<td>25%</td>
<td>62.5%</td>
<td>8</td>
</tr>
<tr>
<td>average</td>
<td>10%</td>
<td>10%</td>
<td>20%</td>
<td>60%</td>
<td>10</td>
</tr>
<tr>
<td>stronger</td>
<td>0%</td>
<td>14.3%</td>
<td>14.3%</td>
<td>71.4%</td>
<td>7</td>
</tr>
<tr>
<td>Total Lines</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>16</td>
<td>25</td>
</tr>
</tbody>
</table>

& Fig. 4) as shown in (Tab. 3 and Tab. 4). The following content analysis attributes were used for the analysis:

Questions: These are the contextual questions asked by learners during the discussion.

Answers: These are contextual answers and opinions given by learners during the discussion.

Confirmations: These are clarifications sought and evaluations made by the learners during the discussion.

Comments: These are contextual and non-contextual comments made by the learners during the discussion.

Computation of Learning Difficulty Value

From table (1), it can be seen that the Number of Problems (P) is directly proportional to the Average Total Time spent by a group (T). That is P \propto T. This implies that \( P = DT \), that is \( D = \frac{P}{T} \) \( (-1) \)

Where D is the learning difficulty value affected by the content problems (i.e. Knowledge Stimulus and Knowledge Noise). Additionally, studies have shown that the level of difficulty of a content can also be attributed to the following three factors that affect learners' performances but could not be measured.

- Previous knowledge
• Learners’ metacognitive abilities.
• Some learning environment factors.

Therefore P can be defined as \( P = P_r + W \). Where \( P_r \) is the total number of identified contents’ problems (or difficulty items), and the \( W \) is the sum of the three weakness factors that could not be measured earlier.

\[ W = \frac{TGS - STS}{TGS} \]

Also the Average Total Time spent (\( T \)) for learning in our context has two components. These are Time spent during exploration and challenge (i.e. during individual learning), and the Time spent during collaboration (see e-Moderation). These are denoted \( T_r \) and \( T_c \) respectively. \( T \) is therefore defined as \( T = T_r + T_c \)

Therefore learning difficulty value (\( D \)) is given as:

\[ D = \frac{P_r + W}{T_r + T_c} \] (2)

We used the formula (2) to compute the learning difficulty values for each group as shown in (Tab. 5). Some parameters took their values from (Tab. 1).

<table>
<thead>
<tr>
<th>Weakness Factors (W)</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Problems</td>
<td>0.3</td>
<td>0.2</td>
<td>0.13</td>
<td>0.25</td>
</tr>
<tr>
<td>Total Average Time Taken (( T = T_r + T_c ))</td>
<td>98</td>
<td>67</td>
<td>59</td>
<td>41</td>
</tr>
<tr>
<td>Learning Difficulty Value (( D ))</td>
<td>0.095</td>
<td>0.048</td>
<td><strong>0.036</strong></td>
<td>0.055</td>
</tr>
</tbody>
</table>

**Discussion**

Table (5) revealed that as the content difficulty level meets the students’ level of understanding their individual understanding becomes better thus they used lesser time both in individual and collaborative learning activities as is the usual case. However, this finding shows that there is a point, i.e. point of ”diminishing content quality” (DCQ), where the domain content has reached its maximum quality point, and the D-value assumes the least value (i.e. 0.036). Beyond this point the D-value begins to increase again. The author thinks this became possible because the test (i.e. quiz) questions were kept constant for all groups while the domain content continues to change for all groups. Additionally, beyond that point learners may not be able to reflect deeply and do not feel challenged to seek more information, hence they acquire shallow understanding of the content, and the quiz questions may appear more difficult. Thus group 3 is the best performing group among the four groups, registering the best test score and least time deviation (Tab. 1). Table (2) also shows that at point of DCQ majority of learners, mostly the weaker and the average students, should see the content somewhere between normal and very difficult in this case difficult. The author again thinks that the comments made by weaker learner in group 1 and the stronger learner in group 4 vis-à-vis the chat logs of groups 1 and 4 (Fig. 3 & Fig. 4 and Tab. 3 and Tab. 4) revealed that the content difficulty affects group learning participation. When the content was very difficult the weaker student “internally dropped out”. On the other hand, when the content was too easy the stronger learners also “internally dropped out”. These learners participated less in their groups. Internal Drop out is defined as the situation where a learner finds it difficult to utilize the domain contents but still associates with the group (Fig. 5). Finally some studies have shown that inadequate communication in the group (Heinz et al, 2007), knowledge gap and learning styles (Brindley et al. 2009), personality and environmental factors (Cheng et al, 2005, Farouck et al, 2010) affect learners participation in their collaborative learning. In addition to those efforts, this study contributes that the level of content difficulty has tendency to affect online collaborative learning. This work intends to add to the voices that advocate strategies in web contents designs (Halvorson, 2010), especially for online community learning for college education.
Conclusion

This paper investigated how content difficulties affect participation in collaborative learning and therefore proposed how content design should be approached for online community learning for college education. This work was motivated by the debate among educational stakeholders in higher education on the quality of the contents on the Internet for learners. The study used action research and content analyses approaches to investigate how the content difficulties affect the collaborative learning activities in terms of time and knowledge construction among experienced, average and novice learners in an online learning community. A “content difficulty demystification process” was used to enable a construction of content with comfort-level by the collaborative effort of both the learners and their instructor to sustain the collaborative engagement of all the learners. An experiment was performed with four groups of learners with each group having all the three types of learners. The findings show that the learning difficulty value due to the number of difficulties in a content is directly proportional to the average time taken for the individual or group learning, and is inversely proportional to their average knowledge score until a point of “diminishing content quality”. This is the point of content comfort-level before and beyond which the content is very difficult or too easy to sustain learners’ effective collaborative learning and knowledge construction. This is because when the content was too difficult or too easy, there was an “internal dropout” among novice and experienced learners respectively from the collaborative learning activities. The paper concludes that for effective collaborative work to be achieved factors such as knowledge gap, personality and environmental factors, and content difficulty level are essential. This work also suggested a mathematical formula for computing learning difficulty comfort-level for a content that can sustain effective collaboration and knowledge construction among all learners in a community for further research.

References


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