

# Effects of Implicit Guidance on Contribution Quality in a Wiki-Based Learning Environment

Sven Heimbuch and Daniel Bodemer,  
sven.heimbuch@uni-due.de, bodemer@uni-due.de  
University of Duisburg-Essen, Germany

**Abstract:** Learning within the scope of collaborative knowledge construction with Wikis offers opportunities for triggering socio-cognitive conflicts through controversies. Since the nature of discussions between users in Wikis is not easily recognisable, we were investigating the effects of visual highlighting as controversy awareness information. In this study we wanted to enable  $N = 81$  participants to produce contributions of higher quality due to focused selection towards relevant contents. We conducted both qualitative and quantitative analyses on Wiki contributions. The addition of visual highlights indicating controversies reinforced students to direct their attention towards important contents discussing the study's subject matter. When their selection behaviour was positively influenced it resulted in higher quality and more elaborate contributions to discussion threads and to the final revision of an article. We conclude that unobtrusive implicit guidance can facilitate collaborative knowledge construction processes and outcomes.

## Introduction

The processes of collaborative knowledge construction with Wikis can be difficult and challenging to users by causing frustration for learners (e.g. Capdeferro & Romero, 2012). This can be either due to its structural setup that is unfamiliar to many first time contributors or the manifold options such a system offers where anybody can edit virtually anything at anytime from anywhere. As a consequence, Wikis provide a fertile ground for controversies and socio-cognitive conflicts to occur. Controversies that are constructive and grounded on the exchange of opinions and different points of view on a specific topic provide opportunities for triggering learning-relevant processes and resulting in higher learning outcomes (e.g. Johnson & Johnson, 1979). These kinds of controversies can induce socio-cognitive conflicts that can be beneficial for learning (e.g. Mugny & Dosie, 1978), by triggering equilibration processes of accommodation and assimilation of new knowledge artefacts into one's individual cognitive system (Piaget, 1977).

In extensions to the individual learner's perspective on socio-cognitive conflicts, conflicts between the socio-technical system and the cognitions of a collaborative user base are explicated in the theory of *co-evolution* in collaborative knowledge construction (Cress & Kimmerle, 2008). Every individual's cognitive system that is participating in collaborative knowledge construction provides potentials for possible conflicts to occur while internalizing or externalizing socially shared artefacts from or into a Wiki as socio-technical system (e.g. Oeberst, Halatchliyski, Kimmerle & Cress, 2014). Collaborative knowledge construction processes with the ability to induce conflicts in either system can mutually influence each other.

In Wikis lie potentials for collaborative knowledge construction with regard to desirable constructive controversies and socio-cognitive conflicts that can be beneficial for a number of learning processes, such occurrences should be made more salient to the user. One approach to achieve this is the implementation of implicit scaffolding measures, such as providing representational guidance (Suthers, 2003) and additional cognitive group awareness information (Bodemer, 2011). Representational guidance has proven to be effective on having an impact on group and individual performances during collaborative tasks by directing participants with external representations, such as minimal obtrusive textual or visual contextual cues (e.g. Chun & Jiang, 1998). Especially the use of representational guidance implementations making use of graphics in computer-supported collaborative learning showed potentials of resulting in higher quality written texts as outcomes (e.g. Janssen, Erkens, Kirschner & Kanselaar, 2010).

In addition to that, cognitive group awareness tools that are focused on gathering and visualizing knowledge-related contextual cues have been successfully implemented as implicit guidance measures to structure collaborative learning processes (e.g. Bodemer & Dehler, 2011). It has been showed that implementations of tools that make specific contributions more salient provide the opportunity to strengthen a group's influence on others and foster learning processes as a result (e.g. Buder & Bodemer, 2008). In large scale online discussions additional visualisations have been proven as effective to implicitly guide readers by promoting a more selective reading behaviour and consequently result in better learning outcomes (e.g. Buder, Schwind, Rudat & Bodemer, 2015). Adding visual support for increasing salience towards discussions about controversial opinions or contradictory

evidence can support the induction of socio-cognitive conflicts. These conflicts have the potentials to initiate restructuring processes of one’s own cognitive system as well as within the socio-technical system that is used for collaborative knowledge construction.

In previous analyses Heimbuch and Bodemer (2014, 2015) reported that specific highlighting of discussions in Wikis with the objective of promoting controversy awareness guides learners towards most relevant contents. This implicit guidance was the result of a more focused selection towards relevant information and furthermore lead to measurably higher positive learning outcomes. Other Wiki-related research has been focused on identifying qualitative indicators by means of article revision metrics (e.g. Halfaker, Kittur, Kraut & Riedl, 2009) or the usage of content analysis for exploratory classifications of discussion page contributions (e.g. Schneider, Passant & Breslin, 2011), but without analysing and comparing the quality of individual contributions. Thus far, it was still unknown what effects additional controversy highlights to a Wiki discussion page have on the quality of the individual contributions to an article and the corresponding discussion threads. Therefore, we conducted detailed qualitative analyses on article and discussion thread contributions of this Wiki-based study where additional visual highlighting aids as implicit guidance have been implemented.

## Method

This experimental study has been conducted in a controlled laboratory setting with  $N = 81$  university students ( $M_{age} = 21.70$ ,  $SD = 2.76$ ), mainly recruited from studies of Applied Cognitive and Media Science. They were randomly assigned to one of three versions of our learning environment, separated by privacy screens. They had to contribute to a pre-existing article and discussions. Due to technical issues at the experiment’s editing stage, some of our analyses had to be performed with a total number of  $N = 79$  participants.

The independent between-subjects factor consisted of three experimental groups reflecting different levels of implicit scaffolding through additionally visualised cognitive group awareness information on the occurrence of content-related controversies. Every group’s Wiki had the same Wikipedia-like structure of the discussion page and identical contents inside the discussion threads. Participants had the task to edit an article on theories of mass extinction events of dinosaurs (“*Cretaceous–Paleogene extinction event*”). The study was divided into two phases: (1) reading the original article and corresponding discussions and (2) contribute to self-selected discussions and edit the article. The control group was provided with a Wiki article and discussion view which was similar to Wikipedia. The other experimental groups had additional visual highlights to the discussion page in form of visual controversy awareness information on the thread title level.

We conducted qualitative content analyses (Mayring, 2014) on the final edits of the individual Wiki articles and on the discussion replies of each participant. The finally derived coding schemes and category formations originated both from deductive and inductive procedures. Wiki article categories have been assigned deductively in accordance with Wikipedia’s guidelines for evaluating an article’s quality. Categories with regard to a discussion reply’s content quality have been formed in an inductive procedure.

## Results

In the following we will present the immediate effects on the contribution quality on the level of discussion threads where the controversy awareness indication was implemented. We further explore the indirect effects on the article level where knowledge artefacts needed to be transferred from the materials inside the different types of discussions.

By using a tertile split on the categorised discussion reply data, over all experimental groups and participants, 30.86% of all participant contributions were rated as lower quality, 58.02% as medium quality and 11.11% as high quality contributions. These numbers are total aggregates of categories associated with discussion reply quality. Reply quality was composed of *Neutrality* (acknowledging both opposing arguments), *New Aspects* (introducing new knowledge artefacts) and *Summarising* (integrating summaries of preceding discussion). Aggregated quality ratings for reply contributions are presented in table 1.

Table 1: Frequencies (and percentages) of cumulative overall quality ratings of discussion thread replies.

	<i>No highlight</i>	<i>Controversy highlight</i>	+ <i>Status highlight</i>
<i>Lower quality</i>	12 (44.44%)	5 (18.52%)	8 (29.63%)
<i>Medium quality</i>	13 (48.15%)	19 (70.37%)	15 (55.56%)
<i>High quality</i>	2 (7.41%)	3 (11.11%)	4 (14.81%)

Over all groups and participants, 16.46% of all final articles were rated as lower quality, 51.90% as medium quality and 31.65% as high quality edits. These numbers are total aggregates of deductively assigned categories based on Wikipedia's article quality evaluation guidelines. Article quality was composed of *Referencing* (using references for article changes), *Structure* (fitting into the article's structure), *Neutrality* (integrating neutral points of view) and *Relevance* (editing is meaningful for the article). Aggregated article quality ratings are presented in table 2.

Table 2: Frequencies (and percentages) of cumulative overall quality ratings of the edited article.

	<i>No highlight</i>	<i>Controversy highlight</i>	+ <i>Status highlight</i>
<i>Lower quality</i>	5 (19.23%)	2 (7.41%)	6 (23.08%)
<i>Medium quality</i>	15 (57.69%)	16 (59.26%)	10 (38.46%)
<i>High quality</i>	6 (23.08%)	9 (33.33%)	10 (38.46%)

## Discussion

When wikis are used for the production of socially shared artefacts in learning environments to foster the processes and outcomes of collaborative knowledge construction, the structures of a Wiki and the amount of information can be challenging for students. Virtually everybody can change any contents at any time in a Wiki which in turn can lead to the occurrence of controversies about contents that can subsequently induce socio-cognitive conflicts. In the present analysis we examined how the quality of contributions has been affected by adding visual controversy information to relevant discussion threads.

We found that highest quality contributions were marginally more frequent when the level of controversy awareness information was raised by providing additional indication on the resolution status. We could also see that when controversy awareness without additional status information was provided the most contributions of medium quality could be found, as well as the lowest number of participants who did not summarise relevant preceding discussions.

Although the numbers were only marginal, we identified the highest overall quality article in the experimental group that has received the most detailed level of controversy awareness and status information. But we also see a rather positive effect for the experimental group that did not receive the controversy status information, since they produced the smallest number of lower quality articles. These findings that are in favour of the effects of the more general information on the mere occurrence of controversies can be due to similar effects that have been found in previous Wiki-related research on collaborative knowledge construction. Medium levels of incongruity of information between the individual cognitive and the socio-technical system have been proven to be the most beneficial for learning (Moskaliuk, Kimmerle & Cress 2009) as well as medium levels of redundancy fostered external accommodation processes (Moskaliuk, Kimmerle & Cress, 2012). The findings of this present analysis are line with research that medium levels of supportive manipulations to scaffold learning processes are beneficially for a number of collaborators.

Finally, in conjunction with our previous quantitative findings (Heimbuch & Bodemer, 2014) these results show that additional representations of controversy awareness information can be effective for the resulting knowledge artefacts. This implicit scaffolding that is designed to help Wiki users to focus and select important contents has shown to be beneficial for effective learning and the outcome in terms of higher quality knowledge construction artefacts. Although this experimental study has been conducted with individuals in a laboratory setting, due to the deployed scenario of Wiki-based knowledge construction the potentials of implicit guidance should be considered for further research on collaborative knowledge construction environments. These findings are relevant for the learning sciences, especially for designing and implementing scaffolding interventions for computer-supported collaborative learning environments.

## References

- Bodemer, D. (2011). Tacit guidance for collaborative multimedia learning. *Computers in Human Behavior*, 27(3), 1079–1086. <http://dx.doi.org/10.1016/j.chb.2010.05.016>
- Bodemer, D., & Dehler, J. (2011). Group awareness in CSCL environments. *Computers in Human Behavior*, 27(3), 1043–1045. <http://dx.doi.org/10.1016/j.chb.2010.07.014>
- Buder, J., & Bodemer, D. (2008). Supporting controversial CSCL discussions with augmented group awareness tools. *International Journal of Computer-Supported Collaborative Learning*, 3(2), 123–139. <http://dx.doi.org/10.1007/s11412-008-9037-5>

- Buder, J., Schwind, C., Rudat, A., & Bodemer, D. (2015). Selective reading of large online forum discussions: The impact of rating visualizations on navigation and learning. *Computers in Human Behavior*, *44*, 191–201. <http://dx.doi.org/10.1016/j.chb.2014.11.043>
- Capdeferro, N., & Romero, M. (2012). Are online learners frustrated with collaborative learning experiences? *The International Review of Research in Open and Distance Learning*, *13*(2), 26–44.
- Chun, M. M., & Jiang, Y. (1998). Contextual Cueing: Implicit Learning and Memory of Visual Context Guides Spatial Attention. *Cognitive Psychology*, *36*(1), 28–71. <http://dx.doi.org/10.1006/cogp.1998.0681>
- Cress, U., & Kimmerle, J. (2008). A systemic and cognitive view on collaborative knowledge building with wikis. *International Journal of Computer-Supported Collaborative Learning*, *3*(2), 105–122. <http://dx.doi.org/10.1007/s11412-007-9035-z>
- Halfaker, A., Kittur, A., Kraut, R., & Riedl, J. (2009). A jury of your peers: quality, experience and ownership in Wikipedia. In *Proceedings of the 5th International Symposium on Wikis and Open Collaboration* (pp. 15:1–15:10). New York, NY: ACM. <http://dx.doi.org/10.1145/1641309.1641332>
- Heimbuch, S., & Bodemer, D. (2014). Supporting Awareness of Content-related Controversies in a Wiki-based Learning Environment. In *Proceedings of The International Symposium on Open Collaboration* (pp. 30:1–30:4). New York, NY: ACM. <http://dx.doi.org/10.1145/2641580.2641607>
- Heimbuch, S., & Bodemer, D. (2015). Let's Talk about Talks: Supporting Knowledge Exchange Processes on Wiki Discussion Pages. In *Ninth International AAAI Conference on Web and Social Media. Wikipedia, a Social Pedia: Research Challenges and Opportunities* (pp. 56–61). Palo Alto, CA: AAAI Press.
- Janssen, J., Erkens, G., Kirschner, P. A., & Kanselaar, G. (2010). Effects of representational guidance during computer-supported collaborative learning. *Instructional Science*, *38*(1), 59–88. <http://dx.doi.org/10.1007/s11251-008-9078-1>
- Johnson, D. W., & Johnson, R. T. (1979). Conflict in the Classroom: Controversy And Learning. *Review of Educational Research*, *49*(1), 51–69. <http://dx.doi.org/10.3102/00346543049001051>
- Mayring, P. (2014). *Qualitative content analysis: theoretical foundation, basic procedures and software solution*. Klagenfurt, Austria.
- Moskaliuk, J., Kimmerle, J., & Cress, U. (2009). Wiki-supported learning and knowledge building: effects of incongruity between knowledge and information. *Journal of Computer Assisted Learning*, *25*(6), 549–561. <http://dx.doi.org/10.1111/j.1365-2729.2009.00331.x>
- Moskaliuk, J., Kimmerle, J., & Cress, U. (2012). Collaborative knowledge building with wikis: The impact of redundancy and polarity. *Computers & Education*, *58*(4), 1049–1057. <http://dx.doi.org/10.1016/j.compedu.2011.11.024>
- Mugny, G., & Doise, W. (1978). Socio-cognitive conflict and structure of individual and collective performances. *European Journal of Social Psychology*, *8*(2), 181–192. <http://dx.doi.org/10.1002/ejsp.2420080204>
- Oeberst, A., Halatchliyski, I., Kimmerle, J., & Cress, U. (2014). Knowledge Construction in Wikipedia: A Systemic-Constructivist Analysis. *Journal of the Learning Sciences*, *23*(2), 149–176. <http://dx.doi.org/10.1080/10508406.2014.888352>
- Piaget, J. (1977). *The development of thought: equilibration of cognitive structures*. New York, NY: Viking Press.
- Schneider, J., Passant, A., & Breslin, J. G. (2011). Understanding and improving Wikipedia article discussion spaces. In *Proceedings of the 2011 ACM Symposium on Applied Computing* (pp. 808–813). New York, NY: ACM. <http://dx.doi.org/10.1145/1982185.1982358>
- Suthers, D. D. (2003). Representational Guidance for Collaborative Inquiry. In J. Andriessen, M. Baker, & D. Suthers (Eds.), *Arguing to Learn* (pp. 27–46). Springer Netherlands. [http://dx.doi.org/10.1007/978-94-017-0781-7\\_2](http://dx.doi.org/10.1007/978-94-017-0781-7_2)

## Acknowledgements

Some quantitative findings of this experiment were reported in Heimbuch and Bodemer (2014, 2015). The presented qualitative categories are grounded on the work of A. Rathje's unpublished Bachelor's thesis (2015).