

Let's Talk about Talks: Supporting Knowledge Exchange Processes on Wiki Discussion Pages

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Abstract

Complex knowledge exchange processes in collaborative knowledge building settings within Wikis can be either supported by providing guidance in form of cognitive group awareness information or by explicitly guiding learners with the help of collaboration scripts. Potentials of analysing and supporting discussants' knowledge building processes focussed on the level of talk pages have still been rarely researched. Our research project comprises a series of three experimental studies and one qualitative study to determine which kind of support is most beneficial for varying types of learners working with Wikis. For this research different fields of computer-supported collaborative learning are integrated and both quantitative and qualitative methods are applied to provide comprehensive analyses in order to provide opportunities for other related research. Presenting and discussing aspects of our research and first results could be beneficial for future research. Our findings suggest that Wiki talk page users can benefit from additional structuring aids.

Introduction

Due to the structures of common Wikis (e.g. Wikipedia based on the popular software MediaWiki), collaborative knowledge building within such environments especially focused on knowledge exchange via article talk pages as a basis for discussions can be a challenging task for participants. Our overarching project goals are (1) to quantitatively and qualitatively analyse knowledge exchange processes in Wikis used in formal and informal educational contexts, (2) to analyse and support communication processes between authors and editors beneficially for learning, and (3) to develop and evaluate Wiki modifications for more effective and efficient collaboration and learning by structuring relevant aspects of collaborative knowledge building.

Knowledge building has originally been defined as the creation of knowledge as a social product (Scardamalia and Bereiter 1994). A significant amount of research has been conducted on how knowledge building and in consequence learning processes can be backed by environments like Internet discussion forums, blogs or Wikis that can be utilised

for computer-supported collaborative learning (CSCL). Collaborative knowledge building in those settings can lead to controversies and furthermore to socio-cognitive conflicts. Such conflicts arising from contradictory information do not have to be detrimental for learning (Mugny and Doise 1978). In collaborative learning scenarios making use of socio-cognitive conflicts plays an important role. Conflicts that emerge if an individual is confronted with a different perspective contradictory to its own cognitive representation can lead to reorganisation and reconstruction of cognitive processes and furthermore to a success in learning, if the achievement of a consensus is required or desired (Bell, Grossen, and Perret-Clermont 1985).

Some research that has been conducted in recent years in the area of knowledge building and arising conflicts especially in Wiki contexts is grounded on Piaget's constructivist school of thought (Cress and Kimmerle 2008). According to the proposed *Co-Evolution Model* of cognitive and social systems, analogous processes of internalisation and externalisation can be found on the individual as well as on a Wiki's system level and mutually influence each other. At every level there are manifold possibilities for socio-cognitive conflicts to arise out of contradictory information or points of view if an individual cognitive system's knowledge base dissents the social system or vice versa.

Supportive measures for dealing with conflicts that have proven to be effective for learners in different contexts range from deployments of implicit guidance approaches, e.g. implementation of cognitive group awareness tools (CGATs) (Janssen and Bodemer 2013), to more explicit instructional methods, e.g. instructional designs through collaboration scripts (Dillenbourg 2002). Wiki talk pages can comprise hidden potentials for knowledge building processes that should be made more salient to interested users by providing guidance to those readers as formal or informal learners in the underlying discussion threads.

On the one hand, the deployment of CGATs that gather and visualise knowledge-related information have been successfully implemented as implicit measures to structure collaborative learning processes (Bodemer and Dehler 2011). Visual feedbacks as external representations of group awareness information have been realised as multidimensional graphs or highlightings specific aspects of interest. Such visualisations can be helpful cues for readers of large on-

line forum discussions to navigate through the contents and select the most relevant information, e.g. based on ratings of contribution quality or agreement to a certain statement (Buder et al. 2015).

The development and evaluation of such CGATs assisting collaborative knowledge exchange processes could be further supported by *Natural Language Processing* (NLP) to (semi-)automate processes where normally manual moderation by administrators or superusers would be inevitable. Computational advancements and research on NLP in recent years yielded into more sophisticated libraries, tools and frameworks (e.g. DKPro TC) for analyses in Wiki-related contexts (Daxenberger and Gurevych 2014). These developments allow researchers to conduct broader and deeper Wiki-based evaluations of text fragments as shared knowledge artefacts with special regards to the identification and processing of controversies and to possibly enable authors and editors to manage subpar structured information more effectively.

On the other hand, explicit guidance methods such as instructional designs through collaboration scripts have been proven itself as effective measures for significant learning effects in different contexts (Johnson, Johnson, and Tjosvold 2000). In Wikipedia's history also one specific instructional set has emerged that can be referred to as script for collaborative writing, i.e. the proposal of the *Bold, Revert, Discuss* cycle (Wikipedia:BRD 2015). Collaboration scripts have to be designed cautiously and should meet several criteria to be beneficial for individuals (Dillenbourg 2002). The possible generation of unintentionally high cognitive load through over-scripting of individuals or groups might lead to unwanted adverse effects on outcomes.

In recent Wiki research, explicit instruction sets to improve collaborative revision processes through scripting methods have produced promising results (Wichmann and Rummel 2013). The successful implementation of a script for collaboration with a focus on increased coordination prior to any integration of knowledge artefacts in a Wiki setting can lead groups to produce more coherent texts and to generate less redundant revisions. The group that worked on the article without any script as control wrote shorter articles, revised the articles less frequent and produced less coherent articles compared to the scripting condition.

In addition to the aforementioned opportunities an explicitly structured workflow can provide for Wikis, the level of coercion as an indicator for the degrees of freedom a collaboration script provides has a measurable impact on the learning success (Papadopoulos, Demetriadis, and Weinberger 2013). Higher coercion in scripted collaboration led to better learning outcomes, achieved by being encouraged to deeper elaborate the learning materials and by lowering extraneous cognitive load.

Because of a Wiki's two layer distinction of article view and its corresponding talk page discussions Wikipedia and most Wiki applications in general differ fundamentally from *classic* threaded Internet discussion forums that have been analysed more extensively. However, fairly little research has been conducted specifically on those Wiki article talks as a layer for potentially relevant knowledge exchange pro-

cesses. Therefore, it is of particular interest to us how authors, editors and readers in (in-)formal Wiki learning settings can be further supported by means of implicit and/or explicit guidance aids to benefit from socio-cognitive conflicts arising from controversies that are led by opposing evidences rather than not proven personal opinions.

In addition to that, our research project covers the influences of specific cognitive and personality constructs that empirical investigations have identified as relevant for learning processes when dealing with controversies and conflicts. These constructs are an individuals (1) need for cognitive closure (Webster and Kruglanski 1994) as an indicator for ones personal preference to either seek or avoid ambiguity and (2) epistemic curiosity (Berlyne 1954) as a personal desire for acquiring knowledge and individual motivation to learn new ideas, eliminate information-gaps, and solve intellectual problems. Both constructs are potential mediators for successful learning and should be considered for further implementations and design recommendations especially when dealing with controversies and socio-cognitive conflicts primarily in (but not limited to) educational contexts.

Furthermore, we are not solely interested in the effectiveness of implicit and explicit guidance measures on the learning success. Taking our considerations one step further, although our main focus lies on the analyses of Wiki talk pages, we are also interested if and how our design implementations can lead to qualitative improvements on the article level by facilitating the integration of multi-faceted points of view.

For our whole project scope of analysing supportive mechanisms for different types of learners in Wiki settings, we have conducted a number of four studies to date. In the first two experimental study, implicit structuring aid as CGATs were implemented to (a) support learners to focus on relevant evidence-led controversies rather than onto not content-related discussions (Heimbuch and Bodemer 2014) and (b) to provide social navigational cues based on author expert ratings to identify and potentially resolve controversies. For the remaining two studies, we were particularly interested in (c) the experimental comparison of two differently focussed collaboration script approaches (Heimbuch, Uhde, and Bodemer 2014) and (d) a qualitative analyses of the status quo of how authors and editors collaboratively work together in articles in Wikipedia.

Methods

The projects' studies implement varying degrees and types of learners support (implicit vs. explicit guidance), focussed on informal learning via conflicting information provided on Wiki talk pages. Learning materials are differing in topics (e.g. mass extinction of dinosaurs, pirate personalities etc.). As an important common ground for all studies we are especially interested in the presence of content-related controversies that are led by evidence, i.e. relevant research, rather than personal opinions.

The initial two studies covered explicit guidance with collaboration script while the first study (work in progress) was a non-experimental qualitative analysis of present data and

for as a second study (completed) we deployed an experimental setting to analyse two variations of collaboration scripts. To research different implementations of implicit guidance measures we conducted a third study (completed) on cognitive group awareness and a fourth study (work in progress) on social navigation. In the latter three experimental studies the individual levels of need for cognitive closure was measured with the German 16-item scale 16-NCCS (Schlink and Walther 2007). Additionally, in the third and fourth study we have also measured epistemic curiosity with the German 10-item scale ECS (Renner 2006).

First study - work in progress

In this study we were specifically interested in a status quo analysis of Wikipedia content creation processes. We were conducting exploratory qualitative process analysis to determine whether we are able to identify any processes that can be either matched to the original by Wikipedia proposed *Bold, Revert, Discuss* script (BRD) or our alternative proposal of a *Talk first, Consensus, Revise* script (TCR), as we have experimentally deployed for the second study, or any other identifiable process of contemporary content creation in Wikipedia.

Therefore, we were randomly sampling a number of Wikipedia articles that had to fulfil several criteria for inclusion in further analytical steps, e.g. minimum article length, number of revision, number of editors, corresponding talk page length. Subsequently, articles and their respective talk pages and revision histories have been segmented and prepared in order to perform matching to sub-processes of both scripting approaches.

Second study

As an associate study to the ongoing qualitative analyses on Wikipedia’s status quo of collaborative knowledge building, we developed a controlled laboratory setting with $N = 28$ participants who were paired into fourteen dyads, aged between 19 and 43 ($M = 23.29, SD = 5.72$). Two different collaboration scripts were implemented into the experimental Wikis and compared against each other as the independent factor. Each dyad was randomly assigned into one or the other scripting group. Figure 1 illustrates the external visual representations of the corresponding collaboration scripts that was permanently visible to each article editor.

The experiment’s *BRD* script is a simplified adaptation of the original *Bold, Revert, Discuss* article creation workflow proposed by Wikipedia, whereas the alternative *TCR* script is self-developed inspired by previous research on coordinated work in Wikis where higher level of coercion to discuss before editing was enacted.

The framework concerning the contents of this study has been on a pirate captain for whom contradictory information on several aspects of his life exist. At first, both participants in a dyad had to establish a common ground on the topic by reading the same basic article that has been derived and by original Wikipedia articles. Followed by that, opposing historical facts (learning material A or B) was presented to either learning partner, in order to enable the emergence of socio-cognitive conflicts between editors.

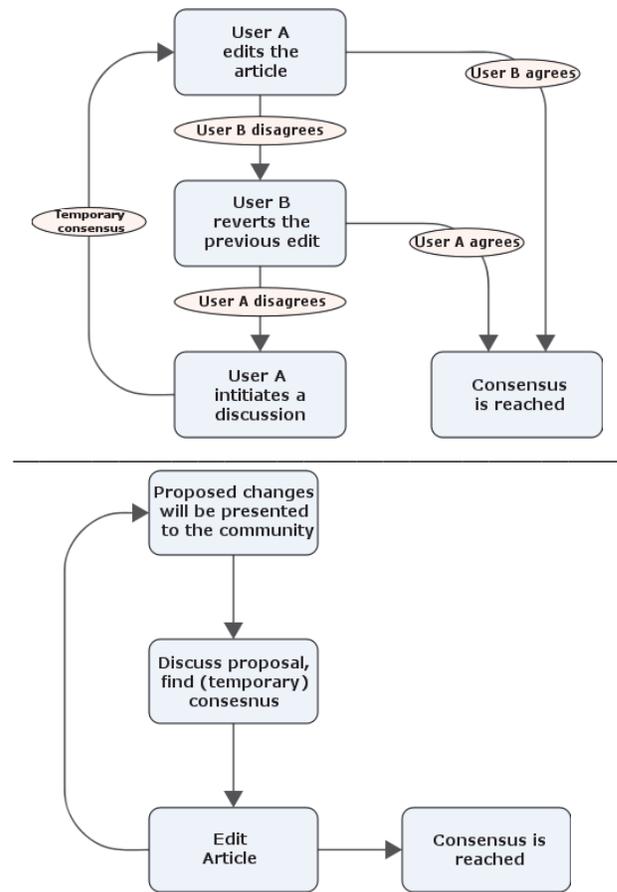


Figure 1: External representations for the article editors’ view of the *BRD* script (top) and *TCR* script (bottom).

The common task for participants in both groups was to collaboratively author the basic article by editing existing paragraphs or adding entirely new knowledge artefacts to the article. After the collaborative writing task both participants had to answer a first multiple choice test (t_1) that should only be completely solvable if contents of both additional learning materials A and B have been made known to each partner. Additionally to the first knowledge test, approximately two weeks later we conducted a post-test with a different set of multiple choice and open questions (t_2). A total number of $N = 22$ participants of the original study have completed this post-test. We also measured the individual levels of need for cognitive closure with the 16-NCCS to analyse possible influences on article quality and performance in both multiple choice tests.

Third study

The design of this study on cognitive group awareness comprised a single independent factor with three levels was randomly varied across the study. The three experimental conditions reflect differing implicit structuring degrees of additionally implemented cognitive group awareness support on controversy information for a number of 24 Wiki talk page

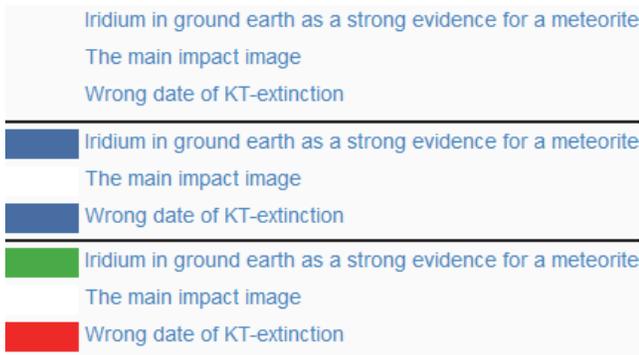


Figure 2: Illustration of a talk page excerpt for all experimental groups: *no Support* (top) vs *plain controversy highlighting* (middle) vs *controversy status highlighting* (bottom).



Figure 3: Illustration of the added visualisations for the experimental group.

discussions (Figure 2).

Study participants in the two supported groups with additional visualisations in the page's table of contents were primarily focussed on meaningful and relevant discussions in order to complete the task of editing a basic Wiki article by themselves. A total of 81 university students (58 females and 23 males), aged 18-30 ($M = 27.70$, $SD = 2.76$), were randomly assigned to the three experimental groups.

Fourth study - work in progress

For this study on implicit guidance with social navigation, we deployed a two factorial design with the addition of an external representation of author ratings as first factor and a three level variation (*content-related* vs *formal* vs *social*) of presented controversy types as second factor (Table). Figure 3 depicts the visualisations added to each author on our experimental Wiki talk pages. The visualisation is split into two parts, (1) a badge representing an author's rank as expert in the specific domain he is currently editing and (2) an adaptation of a *Like*-representation, similar to popular social networking communities, for each author in a discussion thread.

Participants received a total number of fifteen talk page excerpts, either with the above illustrated modifications (cf. Figure 4) or an unmodified Wiki view. After reading a discussion each participant had to fill out a number of short questions and ratings on the presented controversy in a discussion thread. As dependent variables we were collecting data on the number of correct assignments of controversy types, difficulty ratings on the complexity of the different

Die Kritik an der Psychoanalyse ist überwältigend; sie spielt an Universitäten keine Rolle mehr; sie ist nach allen Kriterien, die man dafür anführen kann eine Pseudowissenschaft. Und nichts davon steht in der Einleitung. Das ist nicht neutral. Wikipedia ist aber kein Fanforum, sondern soll die Lemmata enzyklopädisch neutral darstellen. Die vielfältige Kritik sollte sich zumindest in einem Satz in der Einleitung wiederfinden. Psychoanalyse-Gläubige sollten bedenken, dass ihre Ersatzreligion nicht glaubwürdiger wird, wenn man die Kritik zurückdrängt. Ich habe (noch) nichts geändert und habe keine Missionierungsbedürfnis, meine aber, das es schade ist, wenn Wikipedia nicht so zuverlässig wie möglich ist. Also meine Bitte an jemanden, der im Bereich Psychoanalyse kompetent ist: Die vielfältige Kritik kurz in der Einleitung ansprechen. -- Peter Ludolf 3 W+ 12:54, 17. Dez. 2012 (CET)

Früher stand schon etwas zum Stand der P. in der Wissenschaft in der Einleitung und auch im weiteren Artikel, alles wurde aber nach und nach von der "Experten" auf diesem "Fachgebiet" - allesamt natürlich Anhänger der P. - rausgedrängt. zT mit der Begründung, die Kritik sei "unwissenschaftlich", wobei es natürlich ein Treppenwitz ist, dass gerade die P.-Anhänger bei den Kritikern Wissenschaftlichkeit fordern. Viel Glück bei Deinen Versuchen, das zu ändern. Gruß -- Günter Ludolf 15:34, 17. Dez. 2012 (CET)

Die Psychoanalyse ist eine Religion, und Freud ist ihr Gott. Jedwede Kritik wird erfahrungsgemäß von den Gläubigen mit sehr großer Vehemenz abgeschmettert. Das ist bedauerlich, aber derzeit kaum zu ändern. -- Uwe Ludolf 828 W+ 18:55, 18. Dez. 2012 (CET)

Figure 4: Excerpt of an experimentally modified Wiki talk page discussion.

| | (A) Own perspective | (B) Partner's perspective | Total |
|-------------|---------------------|---------------------------|-------|
| Bold script | 12 (8.5) | 2 (5.5) | 14 |
| Talk script | 5 (8.5) | 9 (5.5) | 14 |
| Total | 17 | 11 | 28 |

Table 1: *Frequencies of answers to a test's open question in consideration of different learning materials A and B.*

Note. Values in brackets refer to the expected frequencies.

kinds of controversies and several log data such as processing times of the presented talk page discussions.

Results and Discussion

With respect to the current status of the whole research project, parts of the second study's results are still preliminary and will be partly described with a more qualitative focus. Results for studies 2 and 4 cannot be presented to date, because of the ongoing data acquisition that will be completed by May 2015.

Second study

A t-test for independent samples on the knowledge test scores at t_1 could not reveal any significant differences between participants using the *Bold* script ($M = 10.86$, $SD = 1.79$) and *Talk first* script users ($M = 11.86$, $SD = 2.71$), $t(26) = -1.15$, $p = .130$, $d = 0.44$. Likewise for the post-test scores at t_2 there were no significant differences between the *Bold* group ($M = 8.33$, $SD = 1.87$) and *Talk* group ($M = 8.46$, $SD = 2.18$), $t(20) = -0.16$, $p = .440$, $d = 0.06$.

Evaluation of open questions on the study's controversial topic at t_2 revealed that individual participants in the *Talk* script group integrated significantly more often the point of view of the learning partner in their answers ($\chi^2(169) = 7.34$, $p = .007$, $\phi = .51$) (cf. Table 1). This script facilitated the discussion on the controversial aspects of the differing learning materials A and B and enabled more differentiated answers on the topic compared to the *Bold* group.

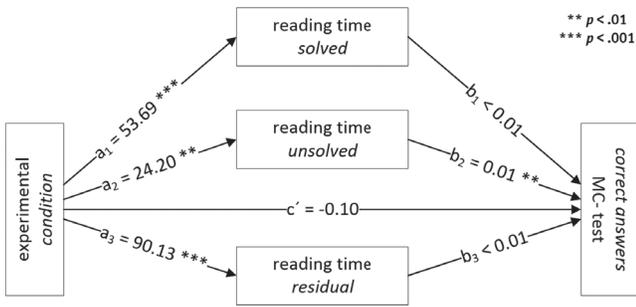


Figure 5: Multiple single-step mediation model on the multiple choice test results. ** $p < .01$, *** $p < .001$

Participants in the *Talk first* script group discussed significantly more than those in the *Bold* group, $t(19.20) = -2.28, p = .017, d = 0.96$. In this regard both scripts worked as intended as the *Talk* group was explicitly encouraged to discuss controversial contents upfront before performing any edits.

We could not find any significant differences in the resulting article lengths between *Bold* script dyads ($M = 1202.57, SD = 99.43$) and *Talk* script dyads ($M = 1218.43, SD = 153.69$), $t(26) = -0.32, p = .374, d = 0.12$. It should be kept in mind that participants in the *Talk* script group spent significantly more time on coordinating and reaching consensus about the final article contents.

As a measure of article quality we counted the number of newly added knowledge artefacts to the basic article. We could not reveal significant differences between *Bold* script participants ($M = 9.43, SD = 2.07$) and the *Talk* script group ($M = 8.43, SD = 2.71$), $t(26) = 1.10, p = .141, d = 0.41$.

Third study

Learning success was measured by a fifteen item multiple-choice knowledge test with three distractors and one attractor. Overall, participants have correctly answered on average $M = 9.85 (SD = 2.11)$ out of fifteen questions. Analysis of variance could not reveal any measurable differences on learning success between the three investigated groups, $F(2, 78) = 0.03, p = .968, \eta^2 < .01$.

We have further investigated the knowledge test scores between all three experimental groups, considering the different categories of discussion threads (*solved* vs *unsolved controversies* vs *residuals*) as mediators in a parallel multiple single-step mediation analysis (Figure 5). If students received a more detailed degree of implicit guidance (*controversystatus* > *plainhighlighting*) and spent more time on intensively reading unsolved conflicts, they performed significantly better in the multiple-choice knowledge test.

Analysis of variance using planned comparisons with an orthogonal Helmert-contrast revealed that in the unsupported control group significantly more topics on the article's talk page were selected, compared to both supported groups (controversy status / plain highlighting) ($F(2, 78) =$

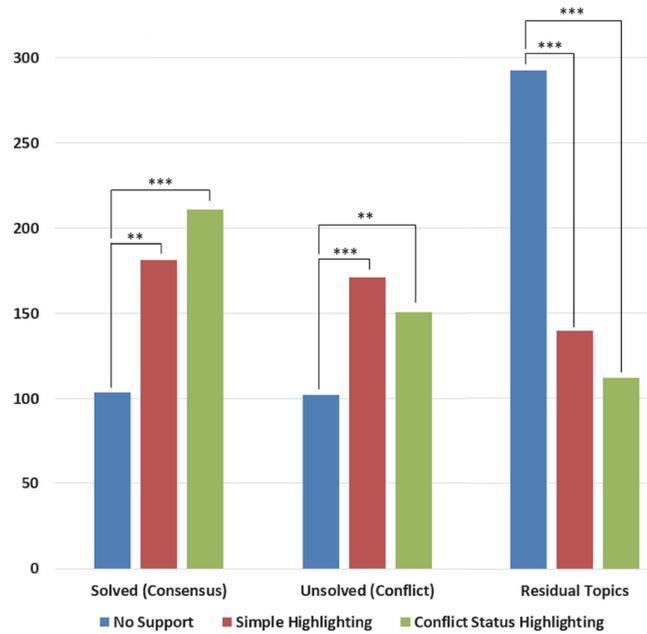


Figure 6: Average accumulated reading times in seconds of differing discussion thread categories. * $p < .05$, ** $p < .01$, *** $p < .001$

| Group | Sequence (thread number) | Support (pattern frequency) |
|--------------------|-----------------------------|--------------------------------|
| No support | 1, 2, 3, 5, 7 | 14 |
| Plain highlighting | 5, 8, 14, 16, 19 | 14 |
| Controversy status | 5, 8, 14 | 16 |
| | 8, 14, 19 | 15 |
| | 5, 8, 19 | 13 |

Table 2: *Most frequent closed sequential patterns.*
Note. Bold print numbers represent the studies most relevant topics (solved [8,14,19] / unsolved [5,16,24] controversies).

3.80, $p = .027, \eta^2 = .09$), indicating a more focussed selection and reading behaviour by providing implicit guidance. This results of a more selective and focussed reading behaviour in either guidance group is further supported by analysing reading times partitioned into the study's different topic categories (Figure 6).

Most frequent closed sequential patterns using CM-ClaSP algorithm (Table 2) indicate that guidance towards the potentially most relevant discussions of interest worked as intended in all experimental groups. In either of the implicitly guided groups, participants preferred to select and read the most relevant topics containing evidence-led conflicting discussions at first. In contrast, participants without additional guidance (no support) showed the tendency to follow a less focussed top-down reading strategy.

General Conclusion

Overall, our results indicate that both strategies of providing additional structuring aids with a focus on Wiki talk pages by implementing cognitive group awareness representations and by providing a specific collaboration script related to socio-cognitive conflicts produced promising results in terms of focussing readers attention towards relevant aspects and facilitating more perspective taking in learners. Furthermore, the results demonstrate that guiding readers and potential editors of articles towards relevant evidenced discussions containing opposing points of view can lead to measurably higher learning success under certain circumstances when considering the individual differences in relevant cognitive variables such as the need for cognitive closure. Due to the fairly small sample size of study C, but yet producing some encouraging results, replications are planned in the laboratory as well as a quasi-experimental or field study deploying a different content-related framework.

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