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Is a GIF Worth a Thousand Words? Understanding the Use of Dynamic Graphical Illustrations for Procedural Knowledge Sharing on wikiHow

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Abstract. Informational presentations in Graphics Interchange Format (GIF), have been commonly used to convey emotional, cultural, and non-verbal cues in computer-mediated communication. However, the usage and impact of animated GIFs in the sharing and consumption of procedural knowledge, such as how-to instructions, remains unclear. In this paper, we leverage an online collaborative procedural knowledge-sharing platform – wikiHow to investigate the roles of GIFs in the construction and editing of How-To tutorials and how multimodal tutorials impact learners' perception and learning from the shared expositions. Through data analytics of archived editing histories, article content and user ratings of wikiHow pages, we found that tutorials consisting of multiple modalities, including animated GIFs and images in addition to text, in general introduced more edits and more textual content compared with text-only articles. When learners learned from these wikiHow tutorials, the tutorials with rich modalities also received higher usefulness evaluation from learners, and accumulated more success stories from the learners in following the tutorials to perform procedural tasks. We discuss the implications for future research on multimodal factors for collaborative procedural knowledge sharing.

Introduction

With the advent of the Internet and computer-mediated communication (CMC) technologies, collaborative knowledge sharing is rising on digital platforms such as Wikipedia, where people distributed around the world may collaborate to make contributions to encyclopedic repositories to provide access to diverse topical knowledge and concepts (Ackerman et al. (2013)). One emerging trend in online knowledge sharing targets at leveraging multimodal information, such as images and videos along with text, to support readers' understanding of the topic. Numerous research work has investigates the integration of text and images in documents with the goal to relieve the cognitive effort for readers to comprehend the content (Viegas (2007); Navarrete and Villaespesa (2020)). However, as knowledge sharing requires authors to actively create expositions to share what they know, how the inclusion of multimodal information affects the construction process of knowledge sharing, such as editing and peer collaboration for producing an exposition useful to learners, is important yet not entirely clear.

Apart from vast knowledge on diverse topics shared by people online today, instructions of procedural skills that teach learners how to accomplish specific tasks are highly practical and frequently needed in daily life. Such procedural knowledge gains increasing popularity in the landscape of knowledge management and emerges as a new genre of online content of increasing demand by online communities to share and to consume. Specifically, How-To instructions refer to procedural knowledge externalized and authored by people that explains how to achieve a desired goal through a series of operational steps (Torrey et al. (2007); Yang and Wang (2019)). For instance, how to fix a disposal, how to bake a Chiffon cake, etc.. Similar to Wikipedia, How-Tos are written and edited by volunteers (wikiHow is one popular platform for authors to share How-Tos; see Figure 1). In comparison with traditional face-to-face knowledge transfer that tends to have limited scalability, volunteering-based online knowledge sharing transcends

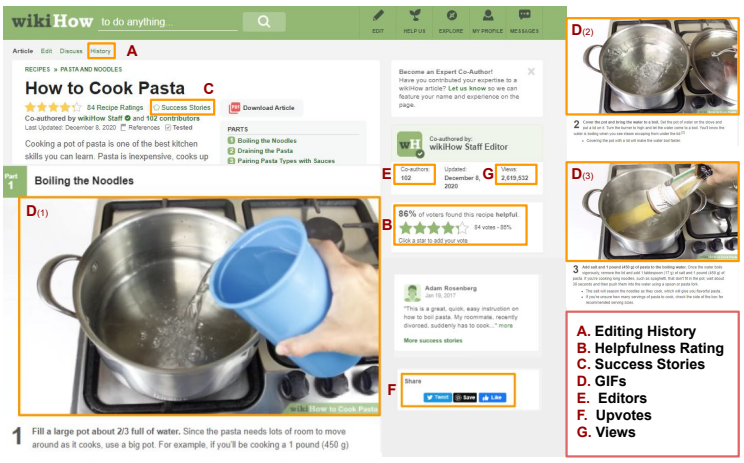

Figure 1: wikiHow as a collaborative procedural knowledge sharing platform.

geographic and social boundaries, enabling the curation of procedural contents from volunteers at a large scale. However, as volunteers don't necessarily possess domain knowledge to the same level, the knowledge gap between editors can potentially cause difficulties in coordination and collaboration during the editing process of How-To instructions, as shown in previous research of Wikipedia by Shaw and Hargittai (2018). Although a lot of work has been done on supporting collaborative editing among volunteers on Wikipedia (Liu and Ram (2011); Brandes et al. (2009)), few work have been done on online procedural knowledge sharing.

Different from knowledge sharing on Wikipedia that tends to focus on the sharing of declarative knowledge, the sharing of procedural knowledge requires editors to externalize the procedural skills they possess, which is in theory more difficult to verbalize and write about than editing regular encyclopedic entries (Yang (2007)). Also, experts may not be able to fully articulate their how-to procedures in a form that novices can understand (Hinds et al. (2001)), as they may unintentionally describe the procedures with abstract forms, personal metaphors or terminologies. Also, what's articulated by one editor may also be hard to be further edited by other editors with inter-editor discrepancies on skills and expertise, which may all hinder procedural knowledge sharing.

On the other hand, sharing procedural knowledge versus sharing conceptual knowledge, as in traditional Wikipedia, may differ in what's the feasible modality of informational presentation to use for exposition and conveyance. Different from conceptual knowledge, procedural knowledge involves also psychomotor skills and operating behaviors (Salaberry (2018)), where images and GIFs are potentially useful for explicating and communicating these skills. The visual representations provide the affordances essential to represent procedural behaviors in instructional forms for learners. In terms of inter-editor collaboration, previous work (Gergle et al. (2013)) has suggested visual information benefits collaborative work by grounding inter-worker communication. Similar visualization effects may also benefit collaborative editing in procedural knowledge sharing given the non-verbal nature of the procedural content to co-author and to share. Based on these observations, we're interested in investigating how multimodal representations (animated GIFs, static images and texts) are used to facilitate how-to instruction authoring among editors and procedural knowledge sharing from experts to novices in the field, such as the online how-to knowledge sharing platform, wikiHow as shown in Fig. 1.

Beyond static images, dynamic graphical representations, such as video and GIFs, have the affordances to illustrate time-dependent processes, such as physical actions and object states visually and can potentially complement other modalities (like text and images) to better convey procedural knowledge. From the learning perspective, inferring the underline meaning of messages conveyed by visual channels may require learners to jointly interpret information coming both from text and graphics, leading to synergistic effects of multimodal learning (Marsh and White (2003)). What remains underexplored is the effects of dynamic graphics (e.g., GIFs) and mixed pictorial representations (e.g., a combination of static images

and GIFs) in procedural knowledge sharing, where text-only expositions can be insufficient for both knowledge sharers and learners given the non-verbal and abstract nature of procedural knowledge (Volker et al. (2003); Hinds et al. (2001)).

In order to gain deeper understanding on how multimodal procedural knowledge sharing occurs by combining text, static images and dynamic graphical representations, and how multimodal instructions created impact novice learners' evaluations of how-to contents, we leverage the online platform wikiHow[1], an community that shares and manages how-to knowledge, to understand how readers' evaluations of tutorials and learning outcomes vary across the modalities adopted to expose procedural knowledge at a large scale.

Background

Graphics Interchange Format (GIF) is a graphic file format increasingly popular in communication and social networking applications for encoding and exchanging animating graphical contents (Bakhshi et al. (2016)). Similar to pictorial emojis, emoticons and stickers, short videos encoded in GIFs are also commonly used as emotional displays, such as animating gestures and facial expressions. The polysemic and intertextual features of GIFs make such format feasible to convey rich personalized expressions, affects and cultural knowledge (Miltner and Highfield (2017); Tolins and Samermit (2016)). Previous works on GIFs mostly focus on investigating the affordances of GIFs in online communication, such as social interactions in social media posts and conversations in instant messages (Jiang et al. (2018)). The utilities of GIFs in the context of knowledge sharing and consumption remains unclear.

Procedural Knowledge Transfer is another line of study aligned with our research. In previous research, Hinds et al. (2001) identified the difficulty during knowledge transfer between experts and novices, where the abstraction level of expertise may block such knowledge transfer. Previous work by Huang and Chiou (2010) also investigates how different media included in the instructions influence the process and outcomes of completing procedural tasks. The result reveals that alternative visual types for instruction should be utilized to facilitate learning. On the other hand, Chirumalla et al. (2015) stated people using text-only instructions for knowledge sharing may take three times longer to accomplish the task than other instructions, while Palmiter et al. (1991) claimed that animated demonstrations performed worse in supporting transfer learning. Therefore, it is important to investigate how to combine different modalities to support effective and efficient knowledge sharing for procedural tasks.

[1] wikiHow Introduction: https://www.wikihow.com/wikiHow:About-wikiHow, Access Date: 10.18.2020

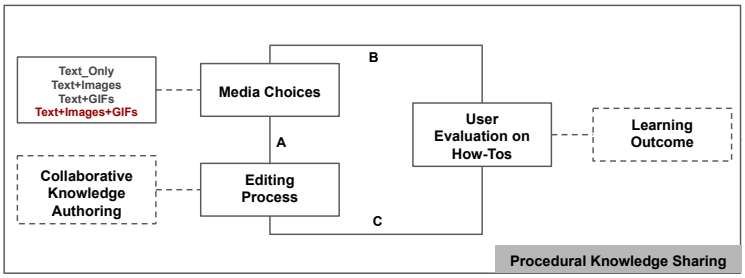

Figure 2: The analysis framework: the framework for analyzing how media modalities affect collaborative editing by editors and learners' ratings of the contents created. The articles are labeled into four categories: text-only, text+images, text+GIFs, text+images+GIFs, according to the media used in the editing history. The correlation between media choices and the collaborative editing process (linkA) is examined. Besides, the connection between media choices, the editing process and the learners' evaluation is investigated (link B & C).

Hypotheses and Analysis Framework

We focus on analyzing all English tutorials posted and shared on wikiHow. We collect two sets of data, including (1) the editing history of tutorials reflecting the behaviors of collaborative authoring by editors and (2) the metadata revealing viewers' interaction behavior when they acquire procedural skills on the platform, for instance, viewers' helpfulness rating and upvotes on articles, success stories and etc..

To examine the roles of multimodal representations in collaborative knowledge sharing for how-to knowledge, we pose the following two hypotheses:

H1: Compared with non-GIF incorporated instructions of procedural knowledge, GIF incorporated instructions trigger more editing behaviors and elicit more textual contents.

H2: Compared with non-GIF incorporated representations of procedural knowledge, GIF incorporated instructions better support regular learners' learning.

To examine aforementioned hypotheses H1 and H2, we follow the analysis framework illustrated by Fig. 2. The framework models the main components that happen during collaborative procedural knowledge sharing, namely collaborative knowledge authoring and novice learners' knowledge consumption, where our focus lies in the middle on how media choices correspond to collaborative knowledge sharing. In the figure, *Link A* represents the potential connection between media choices and collaborative editing activities, while *Link B* and *Link C* indicates the potential connection between media types included in the instructions, edits from editors and the evaluation from novice learners on the instructions. We follow *Link A* to test H1, and follow *Link B, C* to check H2.

Method and Data

To investigate what the editing behaviors and editing outcomes were by volunteer editors when dynamic graphics in GIFs are included in how-to tutorials for knowledge conveyance, as well as viewers' perception and evaluation on how-to instructions using different modalities, we extracted online How-Tos instructions covering various topics and their metadata from wikiHow to conduct statistical analyses of archived data. The metadata included the editing history of each instruction and the viewers' interaction data, such as viewers' helpfulness rating, upvotes and shared successful stories. Each How-To instruction was initialized by an expert editor who wants to share the skill to accomplish a task, then the instruction was edited by multiple volunteers. The viewers were allowed to evaluate how helpful a tutorial was and share their successful experience (i.e., success stories following the tutorial) after consuming the instructions.

With the large-scale data collected, we were able to explore the behaviors of collaborative editing and knowledge sharing in the field. In order to model the influence of graphical representation, four media types were used to encode each tutorial instruction according to the media modalities involved in its editing history: *text only, text+images, text+GIFs text+images+GIFs*. When encoding media types used in tutorials, we carefully cleaned the data by removing noisy edits of multimedia contents, including the insertion of apparently irrelevant images that survived only for one edit (reverted by the following edit) in the editing history. Further, the *number of edits* along history and the *number of words* in the last-version of each instruction are calculated. The purpose is to quantify the effort paid by editors to author the procedural instructions and the externalized information conveyed by the accompanying text respectively. To deal with the confounding effect of the tutorial length and the tutorial age (e.g., an old tutorial usually tends to have more edits and a long tutorial usually contains more textual contents), we carefully normalize the word counts according to the number of steps included by the tutorial. For the edits number, the similar long-tail phenomenon of edits is observed inside time slices as previous work demonstrates (Wilkinson and Huberman (2007)). Therefore, we adopt the similar method to split instructions into four equal-sized time slices according to article ages, the number of articles is equal for each time slice. Then, we log-normalize and time-normalize edits inside the slice along time. Finally, we extract the features related to the viewers, including their *rating on helpfulness* and *the number of success stories* following a tutorial posted by viewers. The reason to extract these ratio numbers is that they are the lightweight signals reflecting novices' evaluation of instructions and learning outcome. In addition, they are measurable signals indirectly revealing viewers' interpretation results. Besides, the number of successful stories is normalized according to the tutorial age to eliminate the legacy effect that the number is accumulative along the time.

In total, the collected dataset covers the archive of 249,465 unique English How-To articles over the past 16 years on the wikiHow platform. These articles

are categorized into 19 main topics (Hobbies and Crafts, Personal Care and Style, Food and Entertaining etc.). 110,694 out of 249,465 (44.37%) pages are marked as stubs in overall due to short length and insufficiently conveying enough information. These stub pages and pages in the quality review process are not included, because low quality pages do not receive feedback from viewers and are not valid for studying collaborative editings. GIFs' usage is of our interest, we therefore count the number and proportion of the articles that include GIFs against the total number of articles of each main topic. GIFs are used in all topic categories, among which "Personal Care and Style" (2,165 out of 11,194) and "Food and Entertaining" (2,501 out of 12,580) topics contain GIFs with the highest proportion (more than 20%). As such, we mostly focus on these two topics for analysis, so that abundant data is available and generalizability exists. Because of an unbalanced distribution across the four media encodings, we apply stratified sampling to the data to reconstruct a representative subset consisting of 1168 samples for empirical data analysis. By doing these steps, we carefully handle the article quality and topic variation.

Preliminary Results

We report the intermediate analysis results and key findings of archived How-To tutorials in this section. The findings are from two perspectives: volunteers' editing activities of tutorial instructions, and viewers' perception and evaluation on these instructions.

Analysis of Knowledge Production

To address the questions of how combinations of different modalities used in tutorials affect the effectiveness of knowledge sharing, we first examined underlying patterns associated with media modalities during the time editors authoring the tutorials. The editing process was of our interest because the tutorial presented to the novices was the production of multi-party work. The editing behaviors directly determined the content of the tutorial, and further influenced the viewers' perception and evaluation. In our preliminary analysis, the normalized number of edits were used to measure editing activities, and normalized word counts were used to measure the editing outcomes.

Media Choices and Editing Behaviors

As How-To instructions on wikiHow evolve all the time, no final versions are available. Our analysis thus could simply focus on the last snapshot of each tutorial by controlling article age and topic statistically as shown in the previous section. The number of edits was first log normalized and then time-normalized, so that a fair comparison can be achieved. To test how editing activities differ between articles that involve different combinations of modalities, we conducted ANOVA and post-hoc Tukey HSD tests by using media modalities used in an article as the independent

variable and normalized number of edits as the dependent variable. The topic was set as a control variable. The result showed a main effect of media modalities used on normalized edit times, $F(3, 1164) = 22.4352, p < 0.0001, \eta = 0.05$. Significant differences were found between rich media combination (including both dynamical GIFs and static images to complement text) and every other media combinations, as well as the text-only baseline (all *p*s<.05), where more edits appeared when GIFs and images were both added to the tutorials at some points. It was worth noting that including only images or only GIFs did not correspond to increasing edits compared with text-only baseline. Besides, introducing GIFs alone was still associated with a significantly higher number of edits compared to introducing static images only. The results revealed that integrating dynamic and static visual information in tutorials is a significant predictor of more productive editing behaviors by the knowledge sharers. There could be either a potential image-elaboration effect where the inclusion of rich media content motivates authors to contribute more edits to elaborate the images/animations, thus potentially share also more and better procedural knowledge; or a potential text-illustration effect where edits to tutorials motivate the needs to include visual representations to clarify the procedures.

Media Choices and Editing Outcomes

In order to quantitatively measure the editing outcomes, we used word counts to approximate the quantity of externalized information conveyed by the accompanying text. Since stop words, such as the most common and short function words (the, a, is...), provided little information, they were filtered out. Procedural instructions to accomplish a task naturally consists of a series of steps. The methods to complete a task could also vary from person to person, thus How-To instructions may possibly involve multiple methods. As such, the measure of word count may inherently confound with the number of methods and steps. It was critically important to normalize word counts based on the number of methods mentioned in a tutorial and the number of steps mentioned in a method, so that the comparison of textual information has face validity among instructions covering different content. Because the normalized word counts neither positively nor negatively correlated with the tutorial age, it's considered unnecessary to normalize along the time.

To examine how the media modalities associate with normalized word counts, we used ANOVA and post-hoc Tukey HSD tests by using media modalities used in an article as the independent variable and normalized word count in the tutorial as the dependent variable. A main effect for media usage was found on normalized word count ($F(3, 1164) = 7.8322, p < 0.0001, \eta = 0.02$). Significant differences were found between rich media combinations (including at least one type of graphical representation, either static images or dynamic GIFs) and text-only baseline (all *p*s<.05). Adding images and animated GIFs, GIFs or images alone, to tutorials is significantly correlated with using more words in describing procedures than text-only baseline.

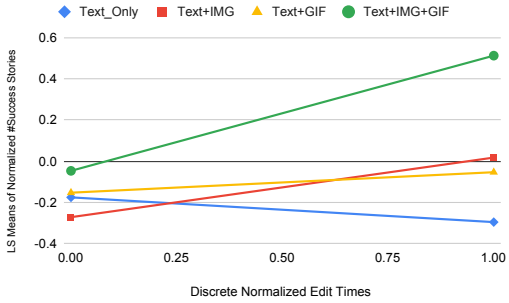

Figure 3: The interaction effect between media types and normalized edit times on the normalized number of successful stories

Analysis of Perception of Shared Knowledge by Learners

Finally, we considered the question how media modalities involved in How-To instructions correlate with the perception and learning from novice learners' perspective. We conducted regression analysis on the media choices and metrics that related to novice learners' perception and evaluation, including *helpfulness rating* and *number of success stories* of each How-To tutorial. Because articles were voted by learners after the instructional tutorials were encountered by different learners, these two metrics were accumulating along the time. As such, the number of edits made by editors were included in the regression model as a control approximating article age.

In order to generalize across different topical contents, the topic was included as a random effect into the model. Besides, the number of success stories was normalized along the time to make a fair comparison. Due to the fact that limited tutorials had a high number of successful stories, the long tail distribution of the successful stories was also log-normalized.

First, the model including media types, normalized edits and helpfulness rating was tested, and there was little collinearity effect in the model (VIF for all factors were smaller than 3.62). The linear regression reported a significant effect of media modalities on the helpfulness rating ($F = 8.5019, p < 0.0001, \eta^2 = 0.02$), which indicated that including images and GIFs into the tutorial significantly influenced viewers' perception of whether the How-To instructions were helpful. The post-hoc Tukey HSD test revealed that novice learners rated articles involving both GIFs and images as being more helpful than text-only counterparts. Including GIFs or images alone also results in significantly higher helpfulness ratings than text-only. However, the difference between including images only versus including GIFs only was not significant on this helpfulness rating.

Further, we explored how different combinations of modalities used in tutorials influence novice learners' successful acquisition of shared procedural knowledge through a linear regression analysis. A main effect was seen for media modalities, normalized edit times and their interaction effect on normalized number of success stories ($F = 5.4514, p < 0.0001, \eta^2 = 0.02$, $F = 21.825, p < 0.001, \eta^2 = 0.01$,

$F = 9.5863, p < 0.0001, \eta^2 = 0.02$). The prediction profiler indicated that less people had learned the procedural knowledge with text-only tutorials under more edits, while more novice learners successfully learned procedural knowledge with How-To instructions under more edits when involving media modalities other than text. To examine the statistical significance for the continuous variable of edit times, we discretized and normalized edit times according to the population median and re-ran the regression analysis for illustration purposes. Fig. 3 showed the increase of edit times significantly correlated with a drastic improvement of the number of successful stories when How-To tutorials included both static images and dynamic GIFs. However, the increase of edit times negatively correlated with the effectiveness of text-only tutorials.

Discussion

Results from our analyses support H1 and H2. The use of short dynamic graphical illustrations in the format of GIF shows the potential to positively transform procedural knowledge sharing. While our analyses are correlational in its nature, the results provide the necessary ground to further consider ways of using animating GIFs to support knowledge sharers and learners in procedural knowledge transfer in future.

H1 states that incorporating GIFs into instructions corresponds to more edits and more textual contents during the tutorial authoring process. In the analysis, we observed increased textual contents when GIFs were introduced to complement tutorial text, however, the edit effort (approximated using the number of edits) did not increase compared to the text-only baseline. The visual representation potentially helps editors better connect and ground their knowledge expositions with the procedural skills they performed and exercised in the real world, which may have facilitated collaborative editing among editors. Grounding with visualizations makes it possible for editors possessing different ideas about the procedure to see the commonalities and differences, allowing different parties to contribute to the tutorial. It's not surprising that introducing both static images and dynamic GIFs corresponded to even more verbalization. However, introducing two types of media did increase editing steps. The reason behind could be that editors need to decide where to put what when heterogeneity of different modalities exists, so that more edits are introduced to ensure content synchronization among combinations of modalities. Another implication is that introducing a mechanism to support collaborative mulimodal editing is necessary to enhance existing wiki-mediated collaborative writing platforms.

H2 is also supported by the analysis result. The observation indicated that richer media correlated to higher learners' evaluation and learning outcomes. When How-To tutorials include both static images and dynamic GIFs, novice learners have greater access to concrete information related to procedural behaviors and object states which approximates the benefits of face-to-face procedural knowledge transfer but in a scalable form.

In addition, the short GIF clips complementing tutorial text may deliver information beyond language barriers which may better assist non-native English-speaking learners. GIFs-incorporated How-To instructions also provide the utility to index specific steps in the procedure with visual representations, which leverage visual and verbal memories at the same time during task execution and help more viewers successfully acquire and perform the procedural task as a result.

Limitations and Future Work

Although we carefully controlled tutorial age, topic and quality when conducting the correlational observation by analyzing the archived data from wikiHow, the current analysis has limitations in making causal inferences. As such, comparative evaluation using experimental methods is necessary to compare how combinations of different modalities used in tutorials directly affect procedural knowledge sharing and transfer. In this case, finer-grained measures and observations will be possible for investigating the causal effects of GIFs and multimodalities in procedural knowledge sharing and consumption, and the conclusion can be potentially used to support the redesign of procedural knowledge sharing systems. In the future, we plan to conduct a qualitative interview study, so that the effects and mechanisms of multimodalities on procedural knowledge sharing can be cross validated by the users' perceptions and experiences.

Multilingualism potentially plays an important role in collaborative procedural knowledge sharing, where editors in different languages may collaborate differently. In this work, we investigated the effect of multimodal representations mainly on wikiHow tutorials in English, since viewers' perception and evaluation are not available for tutorials in other languages. To our best knowledge, non-English tutorials on the wikiHow platform are normally translated from the English version and the rating interaction is not provided for viewers. The research beyond English tutorials is open for future work.

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References

Ackerman, M. S., J. Dachtera, V. Pipek, and V. Wulf (2013): 'Sharing knowledge and expertise: The CSCW view of knowledge management'. *Computer Supported Cooperative Work (CSCW)*, vol. 22, no. 4-6, pp. 531–573.

Bakhshi, S., D. A. Shamma, L. Kennedy, Y. Song, P. De Juan, and J. Kaye (2016): 'Fast, cheap, and good: Why animated GIFs engage us'. In: *Proceedings of the 2016 chi conference on human factors in computing systems*. pp. 575–586.

Bowers, J. M. (1991): 'The Janus Faces of Design: Some Critical Questions for CSCW'. In: J. M. Bowers and S. D. Benford (eds.): *Studies in Computer Supported Cooperative Work: Theory, Practice and Design*. Amsterdam, etc., pp. 333–350, North-Holland.

Brandes, U., P. Kenis, J. Lerner, and D. Van Raaij (2009): 'Network analysis of collaboration structure in Wikipedia'. In: *Proceedings of the 18th international conference on World wide web*. pp. 731–740.

Chi, P.-Y., S. Ahn, A. Ren, M. Dontcheva, W. Li, and B. Hartmann (2012): 'MixT: automatic generation of step-by-step mixed media tutorials'. In: *Proceedings of the 25th annual ACM symposium on User interface software and technology*. pp. 93–102.

Chirumalla, K., Y. Eriksson, P. Eriksson, et al. (2015): 'The influence of different media instructions on solving a procedural task'. In: *DS 80-11 Proceedings of the 20th International Conference on Engineering Design (ICED 15) Vol 11: Human Behaviour in Design, Design Education; Milan, Italy, 27-30.07. 15*. pp. 173–182.

Clark, H. H. and S. E. Brennan (1991): 'Grounding in communication.'.

Gergle, D., R. E. Kraut, and S. R. Fussell (2013): 'Using visual information for grounding and awareness in collaborative tasks'. *Human–Computer Interaction*, vol. 28, no. 1, pp. 1–39.

Gerson, E. M. and S. L. Star (1986): 'Analyzing due process in the workplace'. *ACM Transactions on Office Information Systems*, vol. 4, no. 3, pp. 257–270.

Hinds, P. J., M. Patterson, and J. Pfeffer (2001): 'Bothered by abstraction: The effect of expertise on knowledge transfer and subsequent novice performance.'. *Journal of applied psychology*, vol. 86, no. 6, pp. 1232.

Huang, D.-H. and W.-K. Chiou (2010): 'The effect of using visual information aids on learning performance during larger scale procedural task'. In: *3rd International Conference on Human System Interaction*. pp. 295–299.

Jiang, J. A., C. Fiesler, and J. R. Brubaker (2018): ''The Perfect One' Understanding Communication Practices and Challenges with Animated GIFs'. *Proceedings of the ACM on human-computer interaction*, vol. 2, no. CSCW, pp. 1–20.

Johansen, R. (1988): *Groupware. Computer Support for Business Teams*. New York and London: The Free Press.

Liu, J. and S. Ram (2011): 'Who does what: Collaboration patterns in the wikipedia and their impact on article quality'. *ACM Transactions on Management Information Systems (TMIS)*, vol. 2, no. 2, pp. 1–23.

Marsh, E. E. and M. D. White (2003): 'A taxonomy of relationships between images and text'. *Journal of Documentation*.

Miltner, K. M. and T. Highfield (2017): 'Never gonna GIF you up: Analyzing the cultural significance of the animated GIF'. *Social Media+ Society*, vol. 3, no. 3, pp. 2056305117725223.

Navarrete, T. and E. Villaespesa (2020): 'Image-based information: paintings in Wikipedia'. *Journal of Documentation*.

Palmiter, S., J. Elkerton, and P. Baggett (1991): 'Animated demonstrations vs written instructions for learning procedural tasks: a preliminary investigation'. *International Journal of Man-Machine Studies*, vol. 34, no. 5, pp. 687–701.

Salaberry, M. R. (2018): 'Declarative versus procedural knowledge'. *The TESOL Encyclopedia of English language teaching*, pp. 1–7.

Shaw, A. and E. Hargittai (2018): 'The pipeline of online participation inequalities: The case of Wikipedia editing'. *Journal of communication*, vol. 68, no. 1, pp. 143–168.

Tolins, J. and P. Samermit (2016): 'GIFs as embodied enactments in text-mediated conversation'. *Research on Language and Social Interaction*, vol. 49, no. 2, pp. 75–91.

Torrey, C., D. W. McDonald, B. N. Schilit, and S. Bly (2007): 'How-To pages: Informal systems of expertise sharing'. In: *ECSCW 2007*. Springer, pp. 391–410.

Viegas, F. B. (2007): 'The visual side of wikipedia'. In: *2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07)*. pp. 85–85.

Volker, M. S. A. V. P. et al. (2003): *Sharing expertise: Beyond knowledge management*. MIT press.

Wilkinson, D. M. and B. A. Huberman (2007): 'Cooperation and quality in wikipedia'. In: *Proceedings of the 2007 international symposium on Wikis*. pp. 157–164.

Yang, C.-L. and H.-C. Wang (2019): 'Understanding How Social Prompts Influence Expert's Sharing of How-to Knowledge'. In: *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing*. pp. 433–437.

Yang, J.-T. (2007): 'Knowledge sharing: Investigating appropriate leadership roles and collaborative culture'. *Tourism management*, vol. 28, no. 2, pp. 530–543.