Understanding the Roles and Uses of Web Tutorials

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Abstract

In this paper we identify roles and uses of web-based tutorials through an examination of tutorials' comments sections. Through this analytical lens, we find that web tutorials serve a variety of needs, providing: *in-task help* for users with an immediate, specific goal to accomplish; a means for users to proactively *expand their repertoire of skills*; and an opportunity for novices to *shadow and experience an expert's work practices*. We also find a number of emergent practices in tutorial comments. Users post *"help-me" stack traces,* a type of comment useful for debugging tutorial content; use comments sections as *opportunistic support forums*; and turn to comments sections for *social and technical validation* of their personal skill sets. Collectively, these findings enrich existing perspectives on web-based tutorials and argue for new mechanisms to support these various use cases.

Introduction

Web-based tutorials are a widely prevalent phenomenon: for any popular feature-rich application one can find web-based tutorials. Given their popularity, researchers have recently begun to propose a variety of novel mechanisms to enhance the creation and use of tutorials (e.g. Grabler et al. 2009; Fernquist, Grossman, and Fitzmaurice 2011; Kong et al. 2012; Pongnumkul et al. 2011; Laput et al. 2012; Chi et al. 2012; Lafreniere, Grossman, and Fitzmaurice 2013). However, despite this growing interest, we are unaware of any work that has characterized users' motivations and purposes for using web tutorials, or the social practices that surround them.

To inform future research efforts in this space, we present a qualitative analysis of over 600 comments posted on a sample of web tutorials for commonly searched tasks in Microsoft Word, Excel, and Adobe Photoshop. With this analytical lens, we seek to answer the following questions:

What are users' motivations and purposes for using web tutorials?

What are the emergent conventions and practices within the comment sections of web tutorials?
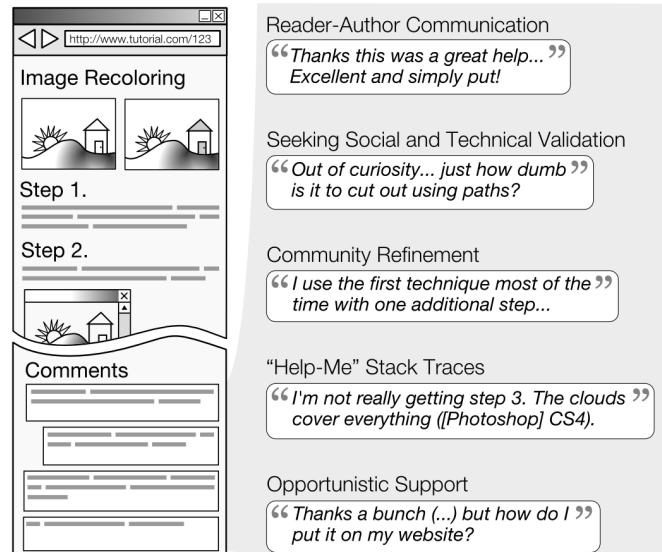
Figure 1. A selection of comments illustrating the social practices we observed in tutorial comment sections.

And based on the answers to the above questions,

How can the design of tutorials and tutorial commenting systems be improved to better support users and their specific needs?

Our analysis reveals that web-based tutorials serve a variety of roles for users, providing: *in-task help* for users with immediate, well-defined goals; a means to *proactively expand one's repertoire of skills*; and an opportunity to *replicate and experience an expert's sophisticated work practices* (what we term *expert shadowing*) to achieve results beyond one's current abilities.

Our analysis also illuminates a number of emergent social practices in tutorial comment systems (Figure 1). We found that: readers post *"help-me" stack traces* that list the actions they took before arriving at an unexpected result; individuals seek *social and technical validation for their personal techniques and workflows* when they differ from those described in the tutorials; users work together to *collaboratively refine tutorial content;* and comment sections are re-appropriated as *opportunistic support forums* for

obtaining help with tasks related to, but also sometimes distinctly different from, the task described by the tutorial.

While a number of these results align with expectations, other findings (such as expert shadowing and "help-me" stack traces) suggest novel ways in which tutorials, their comment systems, and the applications themselves can be improved to better support user needs.

Finally, we present a novel method of sampling web tutorials across the entire web. Our method helps address the difficulty in drawing a representative sample of popular, well-trafficked tutorials for a given application.

In the rest of the paper, we situate our research within prior work, describe our method for sampling and analyzing tutorial comments, present the results of our analysis, and discuss implications for the design of tutorial systems.

Related Work

This work is related to prior research in designing enhanced tutorial systems; analyses of activities in online help systems; and studies of how individuals find and use how-to pages and craft knowledge on the Internet. We review each of these areas in turn.

Enhanced Tutorial Systems

Recently, researchers have begun to propose a variety of novel mechanisms to enhance the creation and use of tutorials. A selection of these projects include creating tutorials by demonstration (Grabler et al. 2009); enhancing tutorials with multimedia content (Chi et al. 2012) or multiple video demonstrations (Lafreniere, Grossman, and Fitzmaurice 2013); helping the user to compare alternate workflows for performing a task (Kong et al. 2012); translating tutorials between similar applications (Ramesh et al. 2011); converting tutorials into web-based applications that can automatically apply tutorial instructions to a document (Laput et al. 2012); and providing variable assistance to the user so they can experience success while following a tutorial (Fernquist, Grossman, and Fitzmaurice 2011).

Collectively, this prior work demonstrates many novel ways to enhance tutorial creation and use, but largely leaves open the questions of *why* users seek out tutorials and *how* they use them. We complement this work by identifying *classes* of intents for people using web tutorials.

Analyses of Online Help

Past research has also examined uses of online help systems, particularly those with a question/answer paradigm (i.e., a user poses a question and an expert or other users respond). Studies of these systems have investigated the time or number of messages before a question is resolved (Mamykina et al. 2011; Singh, Twidale, and Nichols 2009); rates of successful responses (Chilana, Grossman,

and Fitzmaurice 2011; Mamykina et al. 2011; Singh, Twidale, and Nichols 2009); types of requests or responses (Chilana, Grossman, and Fitzmaurice 2011; Mamykina et al. 2011; Singh, Twidale, and Nichols 2009); and multimedia formats used to articulate problems or solutions (Chilana, Grossman, and Fitzmaurice 2011).

In contrast, tutorials have a qualitatively different structure, one in which the question/answer paradigm is inverted. Instead of a user asking a question and receiving a response, authors of tutorials create and share content. Readers are then free to make use of this content and may choose to respond to it. Our work complements studies of other forms of online help by investigating the practices that surround this different paradigm.

Apart from studies of online help with a question/answer paradigm, Kong *et al.* conducted a study to investigate how users find tutorials, and the attributes that they use when selecting between different workflows for performing a task (Kong et al. 2012). Our analysis complements this research by considering the uses and practices of users once they've selected a tutorial to engage with.

How-To Pages and Craft Knowledge

While we are unaware of any work that has systematically examined the roles and uses of tutorials for feature-rich software, these types of tutorials share some similarities with the how-to documents for DIY or craft projects studied in Torrey, Churchill, and McDonald 2009. Both provide step-by-step instructions, and users face the problem of interpreting (and possibly enacting) documented steps.

In their study, Torrey *et al.* found that individuals made use of the Internet for technical information, but also for inspiration or to connect with other people around a craft. We find evidence of these uses for feature-rich software tutorials as well.

Their study also found that users can encounter difficulties making sense of online information when their own materials or tools for a craft differed from those of a tutorial's author, and that users often needed to enact online instructions about physical crafts to gain a full understanding of them. Paralleling these findings, we found that users encountered difficulties when their version of an application differed from that of the tutorial author. We also found that users gain particular benefit from carrying out tutorial instructions step-by-step, rather than simply reading them.

Method

In this research, we analyzed the comments left by users in the comments section of web-based tutorials, constraining our inquiry to tutorials authored using text and images. While video is a popular medium for tutorials, we chose to restrict this initial inquiry to the comments found in text- and image-based tutorials.

User comments provide two joint perspectives on tutorials: An understanding of how and why people use web-based tutorials, and a sense of how well the medium (text- and image-centric content with a commenting system) supports users' needs. While interviews and observational studies would provide additional insights into the experiences of individual users, analyzing user comments allowed us to sample from a wide range of tutorials for several different applications, providing a broad overview of users' practices. The value of user comments has been previously demonstrated in research into discussion forums for open-source software (Singh, Twidale, and Nichols 2009), and a preliminary analysis we performed suggested that they constitute a rich, ecologically valid data source.

Given our chosen focus, we initially examined the comments of tutorials found on tutorial aggregator sites. However, we found that the quality and popularity of tutorials on these sites varied widely. To achieve what we believe to be a more representative cross-section of popular tutorials on the web, we developed a sampling method employing CUTS (Fourney, Mann, and Terry 2011), a technique that approximates the top Google search queries for software. Using CUTS, we approximated the top search queries for three applications: Microsoft Word, Excel, and Adobe Photoshop. We filtered this list to include only queries containing "how to" (e.g. "how to feather in photoshop"), reasoning that queries of this form are likely to resolve to instructional web pages. We then examined this filtered list and selected the three highest ranked queries that indicated specific tasks for each application, filtering out broad queries such as "how to use photoshop" and queries not related to using the application itself (such as "how to get photoshop for free"). The resulting queries are shown below.

"how to cut out an image in photoshop"
"how to feather in photoshop"
"how to make a mixtape cover in photoshop"
"how to convert ms word to pdf"
"how to delete a page in ms word"
"how to count words in ms word"
"how to rotate text in ms word"
"how to make a graph in excel"
"how to merge cells in excel"
"how to lock cells in excel"

Next, we executed each search using Google and inspected the pages returned, starting with the highest-ranked result. Pages were included in our sample if they provided sequential instructions, delivered content using text and/or images, included a commenting system, and included at least one user comment. We examined the first four pages of Google search results for each query and saved the first five tutorial pages meeting the above criteria. This sampling process yielded 42 tutorials (Excel 15, Word 14, Photoshop 13) from 30 unique domains, with a total of 664 comments (Excel 199, Word 192, Photoshop 273).

Code	Comments	%
Praise and encouragement	279	42
Thanking the author	188	28
Responding to another user	115	17
Discussing the application	109	16
Questions beyond the process of the tutorial	82	12
Mentioning a specific version of the application	75	11
Mentioning a problem or failing (either in use of the tutorial, or in tutorial content)	66	10
Suggestion of alternate methods, solutions, or improvements to the tutorial	66	10
Post by the tutorial author	58	9
Sharing personal results from using the tutorial, or personal context around use of the tutorial	53	8
Request for clarification (e.g. of tutorial instructions or another user's comment)	49	7
Providing tips or advice related to the tutorial	42	6
Discussing the end results of the tutorial technique	40	6
Includes a URL	40	6
Provides context around part of the tutorial where the user encountered problems	39	6

Table 1. Counts of comments labeled with each code, for codes assigned to greater than 5% of comments.

Comments were qualitatively analyzed following an open coding protocol derived from the methodology of grounded theory (Corbin and Strauss 2007). Our initial coding scheme was developed in a preliminary study in which we examined Photoshop tutorials posted to tutorial aggregator sites. The first author applied this coding scheme to our final data set, evolving the coding scheme as necessary during the coding process (the scheme required only minor modifications to code our final data set). A summary of the results of our qualitative coding, including all codes that were assigned to more than 5% of comments, is shown in Table 1.

Once all comments had been coded, an iterative process was followed to draw higher-level concepts from the data (also following methodology adapted from Corbin and Strauss 2007). In each iteration we attempted to name and describe emerging concepts and their relationships to one another. These concepts were discussed among the project's researchers, and validated by referencing the raw comment data. This process was repeated until we were satisfied that we had developed a robust theory of users' comments to tutorials, grounded in the comment data.

Tutorial Structure

Before presenting the results of our qualitative analysis, we briefly describe the structure of the tutorials in our sample and their comment sections.

Most tutorials (93%) were conveyed via a sequence of steps, with a median of 6 steps per tutorial (IQR 5, min 0, max 23). Images were common, with 76% of tutorials containing at least one image, and a median of 4 images per tutorial (IQR 6, min 0, max 29).

As a result of our sampling method, all tutorials included an area for user comments. For the majority of tutorials (90%), the comment section was located at the bottom of the page that displayed the tutorial content; for the remaining tutorials, the comment section was located on a separate page. Comments were typically ordered chronologically by posting time (86%), with the remainder ordered based on a score derived from users voting a comment up or down. Half of the tutorials (48%) allowed threaded conversations in comments. The median number of comments per tutorial was 11 (IQR 20, min 1, max 84).

In the sections that follow, we present our analysis of user comments. We first present our findings on how tutorials are used by readers, followed by the social practices we observed in tutorial commenting systems.

Results – Tutorial Uses

In this section we consider what users' comments reveal about their purposes and motivations for using web-based tutorials. We found evidence for two expected uses of tutorials—in-task help, and ongoing skill refinement—and a qualitatively different practice of expert shadowing. We briefly describe the expected uses for completeness, and to provide a point of comparison for other uses of tutorials.

In-Task Help

Perhaps most expectedly, comments indicate that tutorials provide *in-task help* for users in the midst of performing a task that they don't know how to complete. The following comment from an Excel tutorial illustrates this use:

> *Thanks this was a great help…. Excellent and simply put! Got an Excel chart made in a few mins!*

For this type of tutorial use, readers put the tutorial's content to immediate use. The following comment also suggests this immediate need for tutorial content, and underscores the urgency with which some readers seek out this information:

> *Geez thanks so much for this post…i'd been looking franctically for this*

This use of tutorials can be seen as a substitute or complement to in-application help systems.

Expanding One's Repertoire of Skills

Readers also seek tutorials to *proactively expand their skills*. In contrast to in-task help, these readers do not have an immediate, pressing need, but instead seek to increase their expertise with the application, or learn new techniques that could be of use later:

> *Very Nice tut. I think some of these tips will come in handy in my next project.*

From this comment, it is clear that the reader did not have a specific problem that they needed to resolve, and did not actually put the tutorial content to immediate use. This use of tutorials is akin to users reading application-specific magazines or books to increase their knowledge of the application and its capabilities, or to learn how the application is used by other users.

Expert Shadowing

While the previous two uses of tutorials were anticipated, one of our queries ("how to make a mixtape cover in photoshop") uncovered two tutorials whose comments suggest a qualitatively different use. These tutorials have a distinct character compared to the 42 others in our sample: they are long (14 and 23 steps, respectively, compared to a median of 6 for our sample), and they describe how to recreate a complex workflow. For example, one tutorial describes the process for recreating a Ministry of Sound album cover, starting from a blank document.

Comments posted to this latter tutorial suggest that it serves the skill-set expansion use described above, but also suggest a practice of *expert shadowing*, in which the user follows the tutorial step-by-step from its beginning, mimicking the workflow of the tutorial author to create a complex end result beyond their current skill level. For this particular tutorial, 14 comments (of 78) indicated some attempt at performing the tutorial from start to finish. For example:

> *Amazing Tutorial!! Never thought I would be able to make something sooo good. Some tricky bits where I had to search up google for how to do stuff but got there in the end.*
> *THANKS!!! =D*

In this comment, the user enthusiastically expresses a sense of accomplishment, as well as personal ownership over the results ("Never thought I would be able to make something sooo good"). This enthusiasm, coupled with their apparent struggle with some steps (as evidenced by their need to use Google), suggests that the tutorial allowed the user to achieve a result beyond their current level of expertise. The following comment by another user also marvels at the end result and similarly suggests that achieving it required some perseverance:

> *Thanks!*
> *Easy to follow, and gives stunning results after a while of playing around!*

In another comment, a reader posted a link to an image showing their result after completing the tutorial. Save for

some minor personalization, the reader's result was essentially identical to that of the original tutorial. This posting of nearly identical results, combined with comments expressing pride in finishing the tutorial, suggest that successfully completing the tutorial to produce the complex result is the primary goal and achievement for the reader, as opposed to the creative application or adaptation of the techniques to novel problems or contexts. Stated another way, if the application provided a single command that produced the same result, it is unlikely readers would find either the process or the result produced as compelling.

While we only found two expert shadowing tutorials in our sample, we came across entire websites devoted to this type of tutorial during our pilot examination of tutorial content for the study. One such site, Tuts+ (tutsplus.com), pays authors to create tutorials and includes the following text in their "Write for us" section:

> *We prefer more complete, practical and extensive tutorials, placed in the context of professional workflows with high quality final artwork. Tutorials should be 20 steps or more and have an image illustrating each written step.*

That entire sites exist to support expert shadowing suggests that it is a prevalent phenomenon that plays a role in how feature-rich applications are learned and used.

In summary, the differences we observed in terms of the overall intent and use of expert shadowing tutorials suggest a qualitatively different type of tutorial and set of user goals than has been previously identified.

Discussion – Tutorial Uses

Our analysis revealed two expected uses of tutorials, and a qualitatively different use of expert shadowing. While the uses for in-task help and ongoing skill refinement are not surprising, that we found evidence for them in our data set is encouraging because it provides some validation of our use of user comments as a lens to understand how tutorials are used. Furthermore, the practice of expert shadowing suggests rich opportunities for new tools and platforms to support this type of tutorial and its use.

The lengthy, complex tutorials associated with expert shadowing allow readers to walk in the shoes of experts and produce professional-quality results beyond their current abilities. Our findings suggest that users engaged in expert shadowing are seeking an *experience*, not just instruction for learning a new tool or technique. In this experience, they desire to engage in a lengthy process that allows them to produce something they could not otherwise achieve. While they may struggle in the process, they enjoy the challenge and they are proud of their accomplishments in the end.

Considered through the lens of development and learning theory, expert shadowing tutorials allow a user to perform tasks in their Zone of Proximal Development (Vygotsky and Cole 1978)—tasks the user could not perform unaided but can perform with assistance. In other words, these tutorials provide a form of *instructional scaffolding*, supporting the user with aspects of a complex task that they would have trouble with otherwise. Instructional scaffolding is considered to be an effective strategy to promote deeper learning (Wood, Bruner, and Ross 1976), which may suggest a particular learning value for this type of tutorial, in addition to their apparent recreational value.

In terms of implications for next-generation tutorial systems, expert shadowing suggests an opportunity for tutorials and tutorial authoring tools that help produce sophisticated, authentic *learning experiences* for readers that enable them to temporarily assume the role of a professional and complete a complex task. Some initial work in this direction exists by Fernquist *et al.*, who created a tutorial system for drawing tasks that seeks to balance challenge and frustration by providing a variable level of assistance to the user (Fernquist, Grossman, and Fitzmaurice 2011). While this is a first step toward tutorial systems that create compelling learning experiences for users, further work is needed to understand the specific aspects of the expert shadowing experience that are important to users, and how tutorial systems can create them.

Results – Uses of Comments

In this section, we present our findings on the types of comments that readers posted, and more generally the social practices we observed in tutorial comment sections.

Reader-Author Communication

The most common use of comments we observed was to provide praise, encouragement, or thanks to the tutorial author (51% of all comments). Some of these were simple expressions of gratitude (e.g., "Geez thanks so much for this post"). While comparatively rarer, others commented more specifically on the quality of the authoring, as in the following comment:

> *I love tutorials like yours with screen shots. It makes things soooo much easier for visual learners like me!*

Together, the prevalence of these comments suggests that readers truly value the efforts of the tutorial authors. It may also indicate a desire on the reader's part to engage in some form of dialogue with the author.

Skill-Set Validation and Finding the "Best" Way

Comments also suggested that users seek validation for their personal skill sets, as well as a sense of which techniques are "the best." This comment, posted to a Pho-

toshop tutorial on how to cut out a figure in an image, illustrates these themes:

> *Wow. I've never used any of those methods (though I have gotten compliments on how cleanly the image was cut regardless). Man, alive, do I feel stupid. I guess I'll have to try these methods out sometime. Out of curiosity…just how dumb is it to cut out using paths? (Or whatever the photoshop equivalent is…I'm a GIMP'er myself)*

While the user seems self-conscious about not being aware of the techniques presented in the tutorial ("I feel stupid", "…just how dumb is it to cut out using paths?"), they also seek validation for their existing work practices and simultaneously defend them.

More generally, in this and other comments, we found a desire for readers to learn which techniques the community deems the best. This practice complements the notion of using tutorials to refine and expand one's skill set, but in this case the reader turns to the community of readers to achieve this goal, rather than the tutorial content itself.

Human Interpreters and Debugging

In examining reader comments, we sometimes found it useful to invoke the analogy of a tutorial being *executed* by the reader, in much the same way a script or program is executed by a computer. Applying this analogy, we found comments that loosely resemble stack traces to assist in debugging problems that readers encountered:

> *nothing but problems with this in cs4 :s 1st issue was the adding levels and hue/saturation which neither worked because it kept saying slected layer is empty.. so i skipped that and moved onto the line following exactly whats wrote, made the lines saved them as dmap.psd, unhide other layers and delted lines selected text layer filter>distort>displace> pressed ok selected the dmap.psd and then all that happend was the text moved up and to the left a slight bit :s*

Here, the reader provides a sequence of actions taken, the state of the application throughout this sequence (similar to the reporting of variable values in debuggers), and the software version used (Photoshop CS4). The reader's software version seems to be viewed as particularly important in debugging tutorial content, as it was mentioned in 33% of comments reporting problems.

The information provided by these types of comments serves to document common failures of a tutorial's instructions. For the tutorial author, this information could be useful for correcting or improving tutorial instructions, or generalizing them to other versions of the software. For other readers, this information could help them avoid common pitfalls.

Community Refinement of the Tutorial Content

In reporting difficulties they had with completing a tutorial, users perform a quality assurance role for the tutorial, testing whether techniques worked or didn't work in particular versions of the software. In an exceptional example, we observed a user consciously taking on this role and testing a solution on a range of different versions:

> *Wow, I can't remember coming across this Fill>Justify tip before. Nice one. I checked Excel 2003, 2007, 2010, and Mac versions 2008, and 2011 to see if it works and it did. Amazing!*

Users also directly improved tutorial content by providing information to other users. 16% of comments provided advice, suggestions, or alternate methods of solving a problem. The following comment is an example of this:

> *I use the first technique most of the time with one additional step. Using the Filter>Other>High Pass filter before the levels adjustment puts a ghostly halo around the figure that really separates it from the background. It makes the selection that much easier.*

These posts, and users' responses to them, act as in-place community refinements to the tutorial content.

Opportunistic Support Forums

In addition to seeking assistance with steps of the tutorial, readers also sought assistance with tasks related to, but distinct from, the tutorial content, as the following two comments demonstrate:

> *Thanks a bunch!! I created a chart in Excel, but how do I put it on my website? I can't seem to save it as an image? Is there any way to convert the Excel chart to an image? Thanks*

> *Is there a way to merge two columns of dates in this similar way but only combine the dates that appear on both columns? ie. without duplicating them in the newly created column?*

While the above comments ask questions about tasks that logically follow from the tasks in the posted tutorials, we observed other cases where the help requests were only superficially related to the tutorial content. An extreme example comes from a tutorial on how to delete stubborn page or column breaks in Word. The user's question is about how to delete a horizontal line inserted by Word's automatic formatting when the user types "----":

> *In a newsletter that I edit, I keep having a problem that after each item, I put in a line by '----' most of the way across the page.*
> *When I go to edit this later, I cannot get rid of the line. I am using Word 2000.*

The 'What's this' help thing tells me that the paragraph style is Direct: Border: Bottom (single solid line)

This question has only a loose connection to the problem of removing page and section breaks, though there are obvious conceptual similarities. Despite this, the user received a good answer to their question:

In Word 2003, you can do at least two things to delete an unwanted line (aka border):
1) Click Format > Styles and Formatting > Clear Formatting.
2) Position your cursor on the line. Click the arrow next to the border icon (it looks like a square or an underline depending on what border effect you last used). Click the "No Border" icon.

We speculate that the users who ask these questions perceive the tutorial as a gathering place for individuals with knowledge about a particular context of use in the application, and thus re-appropriate the site to ask about tasks related or similar to the tutorial's task.

Discussion – Five Classes of Comment Use

Web-based tutorials follow a qualitatively different paradigm from other forms of online help such as forums, question and answer sites, and web-based technical support systems. With web tutorials, an author creates and shares content with the hope that it will be useful to others. Our analysis revealed that the comment sections of these tutorials provide a number of useful services in support of this paradigm. First, comment sections provide readers with a communication channel to connect with the tutorial authors and other users of the tutorial (e.g., allowing readers to offer praise or thanks to the author, as we observed). They also provide readers with a means of indicating what parts of the tutorial don't "work" for them (e.g. through the manually created "stack traces" we observed), or additional tasks that would be useful to cover (as in the requests for help with related tasks or extensions of tutorial material).

The current form of these comment systems is typically a linear list of comments ordered by date and displayed at the end of the tutorial. While this design is sufficient to create a sense of community around the tutorial and provide readers with a means of communicating with the tutorial author, there are a number of ways in which the overall medium (the tutorial combined with its comment system), and the applications themselves, could be improved to leverage and support the other practices that we observed.

In particular, our analysis revealed five classes of uses for comment systems: Reader-Author Communication; Skill-Set Validation; Debugging; Community Refinement of Tutorial Content; and Opportunistic Support. For each of these classes, we can consider *how* to best support the practice, as well as *where* (i.e., in the tutorial, in the application, or some combination of the two). This leads to a design space for tutorial comment systems.

Self-Organizing Comment Systems

As an example use of the above framing, we often find several of these different classes of comments associated with a given tutorial. A promising avenue would be to investigate whether commenting systems could be enhanced so the community (or system) could tag the intent of each comment (e.g., troubleshooting question, alternate technique, thanks, etc.). Such an approach could draw inspiration from recent argumentation systems like Luther's PathFinder citizen science tool, which uses tagging of comments to structure discussions and enable collaborative data analysis by citizen scientists (Luther et al. 2009). The successful elements of Q&A sites could also be leveraged, such as those on StackOverflow, which has managed to separate conversational and informational contributions (Mamykina et al. 2011).

Including this additional meta-data with comments would allow a tutorial system to organize and reason about them, enabling the dynamic organization and presentation of comments to provide value to the author and other users of the tutorial. For example, comments that refer to a particular tutorial step could be presented alongside that step, where they are more likely to be of use to the reader. Similarly, comments that are useful for refining or fixing the tutorial content could be presented directly to the author, or collected in one spot for reference by subsequent readers. To support skill-set validation, alternative techniques could be tagged as such and organized to allow individuals to quickly compare and contrast the different options.

Collaborative Tutorial Refinement

Readers frequently used comments to report problematic portions of the tutorial (for example posting "help-me" stack traces), or to provide advice, suggestions, or alternate methods of solving a problem. This suggests an opportunity to provide users with the means to directly correct or refine tutorial content *in place*, rather than in a comment section separated from the tutorial content. This would allow the community to improve the original document in much the same way wikis allow the community to improve content. These improvements could appear on-demand in tooltips and/or be moderated so the author of the tutorial could maintain control of the primary content.

Tutorial-Application Integration

The practice of providing "help-me" stack traces argues for facilities that integrate tutorials with the software applications they document. This could enhance the ability of a community of end-users to collaboratively debug problems

encountered when using a tutorial. For example, when a user encounters a problem while following a tutorial, their application could report its recent history, the state of the application and/or document, and its version.

Even richer contextual information could be gained by linking the application with the tutorial, so both are aware of the user's progress as they proceed through the tutorial steps. The application could report on a step-by-step basis how closely the user's actions and document states match those of the tutorial. Some work in this vein has been explored in the Pause-and-Play system, which automatically pauses and resumes playback of video tutorials to match the user's progress (Pongnumkul et al. 2011); and Community Enhanced Tutorials, which integrate a fully-featured image editing application into a web tutorial to capture demonstration videos from users of the tutorial (Lafreniere, Grossman, and Fitzmaurice 2013).

Some software currently provides application state and version information as part of "Customer Involvement Programs" to assist with general product support, but this data is typically low-level and produced with the intent of debugging internal, potentially errant functionality of the application. In contrast, our results advocate for information at a level that would enable a community of users to collaboratively help an individual debug high-level, task-centric problems in the context of their work. Similar appeals have been made for richer contextual information to assist with general product support (Chilana, Grossman, and Fitzmaurice 2011). For tutorials, there is an opportunity to exploit the fact that the user is attempting to follow a well-specified, known set of steps.

Conclusion and Future Work

Through an analysis of over 600 comments posted to tutorials for commonly performed tasks, we identified a range of uses of tutorials and their commenting systems. Beyond the expected uses of tutorials, the practice of expert shadowing suggests an opportunity to create a qualitatively different type of tutorial platform, one that creates sophisticated learning experiences for users. Our analysis of commenting practices suggest a design space of potential next-generation tutorial systems that could enable a community of users to assist one another with performing high-level tasks in complex software.

Given the focus of our analysis, we only included tutorials with comments in our sample. As a result, our characterizations of tutorial uses may not be exhaustive. However, we believe these results provide an important first look at the practices surrounding use of web tutorials.

Investigating the ideas we have suggested for next-generation tutorial systems constitutes a rich area for future work. In addition, it would be valuable to more closely examine the expert shadowing phenomenon through interviews or lab studies. Finally, a natural next step would be to extend the analyses presented here to video tutorials.

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