Experiential Tutorials: Designing Tutorial Authoring Tools to Facilitate Tacit Knowledge Exchange in Creative Practices

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ABSTRACT

Tutorials serve as a fundamental mechanism for disseminating knowledge within creative practices. Yet, tutorials struggle to convey tacit knowledge, a type of knowledge that practitioners internalize over time and experience. The subconscious nature of tacit knowledge often causes experienced practitioners to inadvertently omit fundamental actions in their instructions, which poses significant challenges for novices attempting to grasp the basics. However, no two novices are alike, making it challenging and burdensome for the tutorial author to align their tutorials with the audiences' expertise. My doctoral research aims to create a more bespoke learning experience where tutorials are adapted to learners' experiences without burdening the tutorial author. My contributions towards this goal include a tutorial concept extraction method that identifies the core vocabulary of a practice to inform authors of their audiences' language, a typology that aids authors to identify key characteristics of tacit knowledge to enable richer instructions, and a framework that enables authors to use the tutorial medium effectively to maximize tacit knowledge transfer. I am currently working towards a tutorial authoring tool that leverages large language models to extract a learner's unique and relevant experiences to create a personal knowledge inventory. Future work would combine this inventory with previous contributions to augment tutorials to be experiential, or aligned with learners' experiences.

CCS CONCEPTS

• **Human-centered computing** **Collaborative filtering**; • **Applied computing** *Fine arts*; • **Information systems** *Collaborative and social computing systems and tools*.

KEYWORDS

tutorials, tutorial authoring tools, tacit knowledge, creative practices

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1 INTRODUCTION

In today's digital landscape, tutorials are fundamental for disseminating instructional content. However, they consistently fall short in transferring tacit knowledge, which encompasses the intuitive, often unspoken insights that practitioners develop through prolonged engagement with their crafts. This type of knowledge, internalized and rendered subconscious over time, frequently leads to instructional gaps where fundamental actions are overlooked, making it difficult for novices to acquire foundational skills. Furthermore, the diversity of novice learners, each with unique backgrounds and levels of understanding compounds the challenge, rendering it tedious, if not impossible, for authors to tailor tutorials that meet varied expertise levels. Consequently, there exists a marked disconnect between the depth of knowledge held by experienced practitioners and the instructional content accessible to learners.

Research efforts in intelligent tutorial systems and tutorial authoring tools primarily focus on improving the visibility and presentation of the tutorial content such as updating tutorial visuals to maintain consistency [7], automatically generating static visual step-by-step tutorials from demonstration recordings [6], segmenting creative live streaming videos based on content [5], and removing repetition, silences, and mistakes from demonstration recordings [1]. Context-matching approaches have endeavored to match the learners' needs with available information through techniques like orientation mapping [9] or retargeting information to contextual form factors [8]. While these strategies are effective in making the tutorial content cognitively digestible, the extent to which tacit knowledge is communicated through instructions remains limited as a result of a lack of shared experiences and vocabularies.

How can we aid tutorial authors to effectively bridge the gap in tacit knowledge to create content that resonates with the diverse expertise and experiences of their audience?

My doctoral research aims to address this question by enabling tutorial authors to create more bespoke learning experiences for their audiences without overburdening themselves. My proposed solution is to aid authors in creating experiential tutorials, which are designed to provide a learning experience that is deeply personalized, tapping into the individual's own experiences, knowledge, and skills. Unlike standard tutorials that typically deliver content in a one-size-fits–all manner, instructions in experiential tutorials are grounded in terms that resonate with the learners' vocabularies and experiences, enhanced to specifically include language that communicates the tacit qualities of the task, and presented in a manner that maximizes the tacit communication bandwidth.

As a standing example, consider the simple physical computing task of building an LED circuit on a breadboard. The tutorial author typically begins by enumerating the necessary components, followed by a step-by-step assembly demonstration. Given the physical nature of the task, which demands the use of both hands, the filming often adopts a static overhead perspective to capture the entire workspace. A voiceover walks through the technical aspects like the LED's polarity, the resistor's specifications, and the power requirements to illuminate the LED.

However, this format can be limiting. It presupposes familiarity with breadboard use, overlooking a learner's potential inexperience. The small size of electronic components and breadboard holes can challenge visibility, especially from a singular, fixed camera angle and the technical language used to describe components may alienate those unfamiliar with the jargon. Critical yet tacit details—ensuring the full insertion of component legs into the board, understanding the breadboard's segmented connectivity—might not be adequately covered, as these nuanced actions are second nature to the experienced practitioner.

An experiential tutorial would approach this differently. It would be designed to demystify the process, starting with a narrative that contextualizes the task, perhaps by linking it to everyday experiences or common challenges. The video would employ multiple camera angles, including close-ups to clearly show where and how components are inserted, and dynamic shots that capture the nuances of breadboard assembly. The tutorial would avoid jargon, or when necessary, explain it through analogies and visual aids that relate to the learner's daily life or prior knowledge.

The contributions of my doctoral work aim to aid tutorial authors to design experiential tutorials through a targeted suite of tools and methodologies. First, I present a core concept extraction technique from tutorial transcripts that identifies the core vocabulary of a practice to inform authors of familiar jargon [2]. Second, I developed a typology that aids authors to identify key characteristics of tacit knowledge to enable them to write richer instructions [4]. Third, I contribute a framework that enables authors to leverage the tutorial medium effectively to maximize tacit knowledge transfer [3]. I am currently working towards a tool that leverages large language models to minimize the effort in extracting a learner's unique and relevant experiences to create a personal knowledge inventory which can aid in drawing parallels between the instructions of a tutorial and their existing experiences.

2 CAPTURING THE VOCABULARY OF A COMMUNITY OF PRACTICE

The specialized vocabulary and jargon prevalent among practitioners within a Community of Practice often encapsulate a wealth of tacit knowledge. For example, in the realm of physical computing, terms like "debouncing a switch" or "pull-up resistor" are not just technical terms but carry deeper, tacit understandings of electronic behavior and circuit design. Additionally, jargon is often shared between seemingly disparate practices with underlying similarities. For example, in the context of circuit building, debouncing is used to describe the process of stabilizing the signal from a mechanical switch or button to prevent multiple activations from a single press. This term finds a parallel in music production, specifically in audio editing, where "debouncing" refers to the process of removing unwanted, brief sound artifacts or “bounces" from audio tracks to ensure clean playback.

Grasping the core vocabulary of a practice and recognizing its commonalities with other disciplines can equip tutorial authors with language that resonates with their audience. To that end, we developed an NLP based concept characterization technique that analyzed video tutorial transcripts across 25 different CoPs to extract their core concepts [2]. These concepts were ranked using a TF-PDF algorithm to isolate the top 150 concepts most representative of the CoP which were then characterized into materials, tools, and techniques using a large language model. We further conducted a CoP similarity analysis using a concept focused similarity matrix to reveal sites for CoP crosstalk, or shared vocabularies, where materials, tools, and techniques intersect.

The concept characterization technique is valuable in extracting the most important material, tool, and technique concepts to provide a bird's eye view of the practice to the tutorial author. While adept at illuminating established practices, this approach adopts a practice-centric rather than learner-centric lens. Even within a single practice, two different learners might not interpret the same concepts similarly due to their tacit natures. This pointed to a need to identify strategies for tutorial authors to write instructions that maximize their tacit information bandwidth to reach a larger audience.

3 WRITING INSTRUCTIONS FOR TACIT TASKS

Tacit knowledge is inherently unspoken and challenging to articulate. One way to uncover tacit knowledge in instructional content is to consume a variety of tutorials depicting the same task - what one author might overlook, another might highlight. However, this multiplicity approach poses scalability issues for both learners and tutorial authors, raising the question of feasibility in consuming or creating numerous tutorials to ensure a rounded understanding.

To uncover the different facets of tacit knowledge within instructional content, we leveraged a crowd-based technique, capitalizing on the breadth and diversity of experiences and expertise that crowdwork offers [4]. Crowdworkers were presented with GIFs, depicting a familiar motion (whisking) and an unfamiliar material (clay), and asked to provide open-ended descriptions of what they saw. This approach enabled us to gather a large spectrum of written interpretations, which we then analyzed and organized into the Tacit Description Typology (TDT) (Figure 1). TDT consolidated the varied perspectives but also distilled the essence of tacit knowledge, making it more accessible and manageable to encode into tutorials.

TDT identified four overarching qualities of written instructions - Instruction, Experience, Metaphor, and Care. Of these categories, the Metaphor category comprised the most information dense descriptions, capturing nuances of the other categories and highlighting how people liken what they see with seemingly unrelated experiences. This insight resonated with findings from the CoP similarity matrix which demonstrated how practitioners borrow words from other practices to describe certain phenomena and informed

TYPE	SUBTYPE	SUBTYPE DEFINITION	EXAMPLES
EXPERIENCE	Haptics	Characterizes the material's tactile properties	**hard** and rocky [hardness] **soft** and clumped [softness]
	Visuo-haptics	Integrates both visual and haptic modalities	**smooth** [texture] and **dense** [form] **thick** [shape] and **heavy** [weight]
	Visual	Uses only the visual sensing modality to describe the appearance	**glaze** and **glossy** [look] **choppy** [look]
	Sound	Uses a sound word to describe the material or motion	rough and **crunchy** **whispy**
INSTRUCTION	Direction	Characterizes relative displacement in an arbitrary space	**figure eights** [softness] careful **swirls** [shape]
	Motion	Uses a technical word to capture multiple aspects of movement	careful **blending** [common] **aerating** whip [advanced]
	Pace	Describes the speed at which the whisk is being used	**briskly** back and forth **slow** and **moderate**
	Process	Describes the motion as part of a process	fast **repetitive** sideways movement [rhythm] **constant** agitation [duration]
	Stop Condition	Uses the end state of the material or process as a way of describing motion	stir it **until creamy** [material] forceful and **complete** [process]
	Action	Functional descriptions of clay consistencies informed by interactions	hard and **peelable** [interaction] **malleable** [property] and slightly moist
METAPHOR	Metaphor	Draws a comparison with another material or motion	**tofu** firm consistency [food] **bitch slapping motion**
CARE	Care	Refers to the level of care, skill, attitude and intention behind the motion	**steady** [skill] and **purposeful** [attitude] **deliberate** but messy swirls [intention]

ONLY WHISK ONLY CLAY BOTH WHISK AND CLAY

Figure 1: Tacit Description Typology (TDT) [4]. Overview of the typology types and subtypes with example descriptions pertaining to each subtype. The words in the descriptions that correspond to each subtype are bolded, with more granular codes provided in parenthesis. A clay carving tool icon and a whisk icon indicate subtypes that were present in the clay and whisking tasks respectively. An icon combining the carving tool and whisk indicates subtypes that were present in descriptions from both tasks.

the broader idea of morphing instructions to be more experiential rather than technical.

Our approach involved crowdworkers having to interpret and articulate their observations of GIFs through textual descriptions. While this yielded a comprehensive corpus of descriptions, it prompted reflection on the extent to which the GIF format influenced the descriptions. For example, would a long-form video format elicit more nuanced descriptions, or would isolating the material's transformation, without showing the practitioners' hands, alter the descriptive focus? These reflections on medium-specific influences in conveying tacit knowledge allude to the importance of examining the instructional medium's role more broadly, not just in isolated interactions but as a fundamental component in the effective transmission of tacit knowledge.

4 TRANSMITTING TACIT KNOWLEDGE THROUGH DIFFERENT MEDIUMS

Looking through Marshall McLuhan's lens of "The Medium is the Message", the material manifestation of the tutorial, or its medium, has a significant influence on the instructions being conveyed, or its message. For effective tacit knowledge communication, not only do tutorial authors have to write good instructions, they also have to work with the tutorial medium to maximize the tacit information bandwidth to closely replicate the in-person experience. To aid authors in effectively using a tutorial medium, we contributed a taxonomy of medium conventions (Figure 2), or design patterns shared across different mediums, to categorize how text, video and web mediums can variously facilitate or hinder tacit knowledge transmission [3]. The taxonomy was developed using a medium-centric

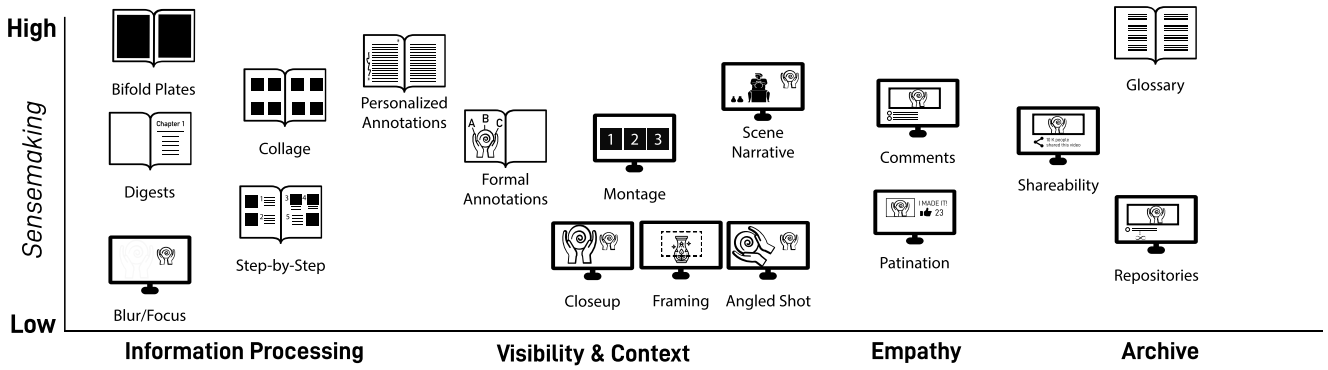

Figure 2: Medium conventions found in our medium analysis [3]. They are plotted along their respective roles in creative sensemaking (x-axis) and their degree of creative sensemaking (y-axis).

thematic analysis that involved a close reading of clay centering tutorials across book, video, and web forms, and a study with five novices in ceramics practices describing their experiences from learning from these tutorials.

A key finding from the analysis and resulting taxonomy was that the framing and curation of visuals in tutorials promoted a false sense of fluidity. Tutorial authors typically only included shots of successful attempts at centering clay as a means of keeping the tutorials attractive and digestible; yet, when novices tried to follow along with these tutorials, their experiences were largely different, causing them to second guess themselves. This finding in particular pointed to a need for experiential tutorials that are tailored to the learners' expertise level, highlighting an opportunity for HCI intervention, given the challenge experts face in reconceptualizing their knowledge from a novice's perspective.

Additionally, we noted substantial knowledge exchange within the comments sections of tutorials, where individuals not only shared their failure experiences but also offered alternative methods, often drawing from similar or technically akin practices. This observation resonated with findings from the Tacit Descriptions Typology and CoP similarity analysis, which indicated that individuals interpreted actions and materials through the lens of their past experiences. However, considering how no two learners share the exact same experiences, there is an opportunity to explore how learners' personal experiences can be extracted at scale.

5 EXTRACTING LEARNERS' PERSONAL KNOWLEDGE INVENTORIES WITH LLMS

My current work focuses on extracting learner experiences using large language models. Understanding expertise in foundational tasks within a practice is crucial for designing experiential tutorials, as this design choice will develop tutorials that align with the learners' current mental models. For novices learning a new skill, identifying experiences in practices that are analogous to the one at hand create the possibility of not having to start from scratch, which can potentially aid in improving confidence and self-efficacy.

However, learners' experiences are also often tacit and difficult to articulate. Tasking an individual with cataloging all relevant experiences for a specific practice would be not only time-consuming but also potentially incomplete. Learners may misjudge their own level of expertise, overlooking critical skills or knowledge they possess or failing to recognize gaps in their understanding.

Large Language Models (LLMs), such as ChatGPT, offer a promising avenue for efficiently extracting personal knowledge or experiences due to their advanced natural language processing capabilities. ChatGPT can engage with individuals in a conversational manner, asking targeted questions and following up on responses to delve deeper into the user's knowledge and experiences. This interactive process can uncover insights that the individual might not have consciously considered, thus bypassing the limitations of self-reporting.

Moreover, LLMs can process vast amounts of information quickly and at scale, making them both time and cost-efficient compared to traditional methods of knowledge elicitation, such as interviews, surveys, and think aloud. They can also adapt the line of questioning in real-time based on the user's responses, ensuring that the conversation stays relevant and productive. This guided approach helps in mapping out the user's tacit knowledge and experiences in a structured manner. However, prompting LLMS to ask effective questions that elicit relevant personal experiences remains an open challenge.

My tentative research plan for this project involves:

- A formative study with a small group of participants to refine the ChatGPT interaction, ensuring it effectively elicits detailed and relevant personal experiences and tacit knowledge.
- Analyze the transcripts of ChatGPT sessions using qualitative data analysis methods to identify key themes, insights, and patterns in tacit knowledge expression.
- Designing a structured set of prompts and questions designed to guide ChatGPT in exploring various dimensions of the participants' knowledge and experience.
- A user study where the refined ChatGPT interaction model will be used to generate a *personal knowledge inventory* for each participant. ChatGPT will then be prompted to use the inventory to generate tutorials for physical computing tasks. Participants will be asked to complete physical computing tasks following ChatGPT tutorials with integrated inventory and with no integrated inventory.

6 FUTURE WORK AND RELEVANCE TO C&C COMMUNITY

Upon completion of my current project, I am interested in integrating the contributions mentioned in this proposal in a comprehensive experiential tutorial authoring tool. The aim of the tool would be to aid tutorial authors in writing richer instructions and presenting them in a form that maximizes tacit knowledge communication. On the learner's side, the tool will expose functionality to create a knowledge inventory which can then be used to augment the instructions in the tutorials.

The "Organic Creative Spaces" theme for Creativity & Cognition 2024 aligns closely with the focus of my doctoral research on developing experiential tutorials. This theme highlights the importance of design harmony with both digital and physical environment to foster a seamless integration into creative practice. My work aims to create educational experiences that resonate with learners' internal frameworks, utilizing diverse tools and methods to tailor tutorials that reflect and respond to individual needs and cognitive patterns. It tackles key issues in creative education, especially the role of digital tools and methods in enhancing learning by facilitating the communication of tacit knowledge. This work has the potential to stimulate discourse on the role of tutorials in knowledge dissemination within and across creative practices within the Creativity & Cognition community.

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