Using Investigative Video Games to Teach Clinical Intuition and Metacognition in Reference Transactions

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As online education for the MLIS becomes widespread, one challenge for reference and user services instructors is that traditional exercises used to promote clinical intuition and metacognition in reference work may be more difficult in online classrooms. This article uses concept analysis to better understand clinical judgment for reference, suggesting that learners' clinical intuition may be developed through a combination of emphasizing types of reasoning skills in reference work and the use of experiential learning theory. Investigative video games are presented as a case for providing practice with reasoning skills and rules testing in contexts adjacent to reference work. The authors provide examples of how types of reasoning are used in these video games and how, when practiced, these can offer a complementary approach to instruction for reference work.

Keywords: clinical intuition, computer-supportive collaborative work, critical reasoning, pedagogy, metacognition, reference instruction, reference transactions, video games

The reference transaction is a form of information literacy work and shares certain didactic and patron autonomy goals as a result. The Association of College and Research Libraries (ACRL) Framework for Information Literacy in Higher Education (Association of College and Research Libraries, 2015), or simply the Framework, marks a perspective shift for those doing information literacy work. The shift involves seeing information literacy less as skills for patrons to master and more as interpretive lenses they can use to see the information landscape more clearly. As with other forms of information literacy work, when reference transactions are carried out artfully, they impart procedural knowledge and decision-making skills that can be useful beyond the duration of the transaction. Unlike some forms of information literacy work, such as formal instruction or online library resource guides, reference transactions are not planned ahead of time. Instruction sessions benefit from lesson plans, rubrics, and matching exercises to desired outcomes. Online guides offer the benefit of design principles, careful curation of known content, and use-metrics to aid in ongoing revision of the guide. By comparison, a reference transaction is a more fluid negotiation of goals and resources, often carried out in real time. The goals of the reference transaction may not be evident at the beginning of an encounter, while the topic of instruction sessions and guides usually are. Due to this initial ambiguity, the reference worker particularly benefits from being able to adapt their approaches to the reference interview, to resource selection, and to search-string construction as new evidence arises. If the reference worker is to be able to satisfy the didactic and autonomy aims expressed in the Framework, they need to possess enough awareness of their decision-making process in context to describe both what they are doing and why it is being done. The central research questions considered here are what capabilities comprise this adaptive awareness,

KEY POINTS:

- The modern reference transaction is a complex set of social, cognitive, and behavioral skills, all of which rely on clinical intuition to provide a sense of effectiveness when serving patrons.

- Metacognition is the educational technique that focuses on knowing what is important for a learner to know at any given point in a lesson and on helping the learner articulate their understanding to themselves and others.

- Many tasks in the reference encounter require the use of reasoning skills. Teaching reasoning skills can aid learners in developing metacognition skills related to reference work. In an online learning environment where it may be difficult to model reference transactions directly, investigative video games may serve as a useful tool for practicing reasoning skills and aid in developing clinical literacy for reference transactions.

and can they be taught in the LIS classroom successfully?

These questions are explored here through concept analysis (CA), a method used in nursing practice to clarify understanding of a phenomenon. Before gathering evidence on a phenomenon, it is important to define it, learn to recognize it, and differentiate it from other concepts. CA is useful particularly for understanding phenomena that must be indirectly observed rather than personally experienced. Once the researcher identifies the phenomenon of interest, the next steps are to situate it in relevant literature, to describe the phenomenon's attributes, and to identify key conditions that are antecedent to it and the consequences of it, as well as any related concepts. A concept analysis closes with a model case to help researchers and practitioners recognize the phenomenon more clearly. The central contribution of this research is to help clarify the phenomena of self and situational awareness in reference, a form of clinical intuition that develops from the real-time, emergent, and interactive nature of reference work.

Understanding this intuition may help course designers identify pedagogical requirements for reference and research support that differ from other forms of information literacy work. In this article, we include a discussion of ways in which existing trends in online education may unintentionally disrupt an important antecedent to reference education and add challenges to acquiring intuition. If clinical intuition is the relevant concept for this phenomenon, it should be part of reference instruction curricula. The next contribution is a conceptual model for teaching intuition that emphasizes ways in which types of reasoning skills, as constitutive attributes of intuition, are used in different phases of the reference encounter. Once the model is introduced, investigative video games are presented as an applied case, an experiential activity to give students supplemental opportunities to develop their clinical intuition in ways that are immersive, interactive, and provide immediate feedback.

Clinical intuition and metacognition

Cognition is an apprehension of the world. It allows people to make the best choices possible within the limits of their faculties and experience. Cognition is also the medium in which education operates, including education for information literacy work. Education

expands the faculties by introducing learners to new concepts. These concepts are reinforced with behavioral and reflective exercises, which expand learners' recall of experiences. We see this mix of an emphasis on concept and experience in the structuring of the Framework. Each frame consists of descriptions of a concept paired with knowledge practices (experiences) and dispositions (faculties). These changes in cognition, brought about by information literacy instruction, help the learner see the world of information differently. It provides procedural knowledge to guide action, and it instills and reinforces the disposition to act in one's best interests when using information. It would be an inefficient way to navigate the world if a learner had to constantly recapitulate the steps of a process as learned in order to solve a problem. If, every time they wanted to know how to use a new information resource, we expected learners to first recall the conceptual knowledge of the parts of information literacy, remember recommended competencies, and associate it with the correct disposition, we would place a burden on them. Instead, instructors hope that learners will integrate these lessons into a single instrument of decision making—in other words, intuition.

Intuition is sometimes described as a gut feeling or hunch, a kind of pre-lingual impulse that is born solely of prior experience and thus is subject to confirmation bias (Badke, 2020, p. 51). It has also been critiqued as the antithesis of research-driven decision making and a legacy of a service orientation in LIS practice (Harris, 1973, p. 269). In this context, intuition is better thought of as a hypothesis or premise, something that is deliberately sought out in situations when a person is presented with a choice of actions to take. Looking to another profession for examples, in nursing we find two related concepts. The first is the idea of clinical judgment, a form of intuition that may be refined with experience (Benner & Tanner, 1987, p. 28). Clinical expertise is a second, related concept which describes a health-care professional's ability to pair prior knowledge, both experiential and research-derived, with the particular demands of a given case (Thornton, 2006, p. 2). Clinical expertise is accumulated tacit and explicit knowledge that guides clinical judgment when patient-care decisions must be made. Clinical expertise, like other forms of cognition, improves with education. Critical judgment can also be refined over time, as the ad hoc rules used to predict causal outcomes are tested for effectiveness in practice (Hogarth, 2001, p. 20). Clinical intuition is a form of professional judgment often discussed in the context of nursing and is a description of nurses' confidence in their ability to infer a patient's needs from their case history and presenting details (Melin-Johansson, Palmqvist, & Rönnberg, 2017, p. 3936). Clinical intuition, in the form of clinical expertise and clinical judgment, is heuristically useful only if the practitioner is able to articulate those ad hoc rules to themselves and didactically useful only if they can be articulated to others. The ability to describe one's intuition is a form of metacognition: thinking about thinking.

Metacognition is a concept widely used in learning theory (Hartman, 2001; Israel, Block, Bauserman, & Kinnucan-Welsch, 2006; Veenman, Van Hout-Wolters, & Afflerbach, 2006). Metacognition is particularly useful in situations where executive management of tasks or strategic knowledge are required. Executive management is the ability to devise the best plan of action in relation to given circumstances, while strategic knowledge allows the learner to describe what assets one has available and when and how those assets should

be deployed (Hartman, 2001, pp. 34–35). In the education of clinical intuition for nurses, Kuiper and Pesut (2004) advocate for what they term self-regulated learning, a balance of critical reasoning skills and metacognitive reflection to promote awareness of "using references and resources, judgments of self-improvement, judgments of self-competence, judgments of resources, self-reactions, and self-correction strategies" (p. 388). Parallels between clinical intuition in a medical setting and the kinds of awareness needed to conduct reference transactions suggest a benefit to seeking ways to educate for intuition in the library and information science (LIS) classroom.

Clinical intuition and reference work

How are metacognition and intuition used by reference workers? Reference workers form and test the effectiveness of ad hoc rules over time as a way of expanding their clinical judgment. Rules are created and tested in relation to conducting reference interviews, selecting resources, and constructing search strings, among other practices. The reference worker uses strategic knowledge to form an ad hoc rule about the most appropriate resource for a given patron request and uses executive management to make rules about the best way to use those resources. These rules can be tested within the span of a single transaction, and they can be refined through reflection between opportunities for practice. An example of such a rule might be the reference worker's preferred approach to conducting the reference interview. Clinical judgment on how to do that may initially be informed by behavioral standards or classroom lectures, but over time a reference worker may use metacognitive reflection to continue to ask whether they had fully answered the patron's question. This is an iterative process. As the reference worker's clinical intuition sharpens, so too can the kinds of metacognitive reflections they use. So the reflective question may transition from something general—"were the patron's needs met?"—to something specific like "was the patron's tacit or unspoken question uncovered?" The same kind of breakdown of ad hoc rule testing and refined reflection occurs in selecting resources and constructing search strings, where the goal is not just procedural, cognitive knowledge but metacognitive awareness of what could have been improved. Being committed to assessment efforts can promote a culture of improved service, but the outcomes of assessments are only as useful as the questions asked and are contingent on reference workers' ability to internalize feedback and refine technique. Clinical judgment and intuition take time and repetition to master, but the responsibilities of the job are often assumed from day one. Educators for these kinds of positions therefore have an obligation to learners and their patrons to help them be as prepared as possible for information literacy work.

The capacity to provide quality reference and user services remains an American Library Association (ALA) core competency (ALA, 2009, sec. 5) and is a core curriculum element according to the International Federation of Library Associations (IFLA, 2012, sec. G2). The knowledge practices outlined in the "Searching as Strategic Exploration" in the Framework list skills that map closely onto those associated with the search portion of the reference transaction and are seen as important in and out of higher education (Association of College and Research Libraries, 2015, p. 22). Proficiency in reference skills is particularly essential for those anticipating careers in academic or special libraries. In the academic

context, reference work aligns with both the research and teaching missions of institutions. In special libraries, reference librarians' skill as expert searchers demonstrates the ongoing benefits of maintaining a library in a professional or corporate setting (Holst & Funk, 2005, p. 50). Reference workers who carry out their duties with high levels of clinical intuition are more likely to demonstrate the worth of the library to community stakeholders. This should be true even in circumstances, such as market research and competitive intelligence, when special librarians are asked to proactively identify sources outside of a consultation model (Black & Gabb, 2016, p. 212). Even outside of these roles, a recent study by Geraci and LaVoice (2020) reported that a third of library job positions listed included reference-related duties in their descriptions, even if it was not their primary job description. The transition in many academic and special libraries to collecting electronic resources, the downsizing of holdings in dedicated reference collections (Johnson, Finley, & Sproles, 2015, p. 171), and the pivot to consultation modes of reference support (Butler & Byrd, 2016, p. 83) resulting in more complicated, research-style requests are all examples of changes in service delivery that have increased demands on those doing reference work. With the stakes for providing quality reference service being high in these roles, and given the frequency with which those skills occur in job titles, it is appropriate to reflect on whether current practices are doing a sufficient job of promoting clinical intuition in those hired to do reference work.

Developing clinical intuition in online learning environments

Beyond demonstrating that metacognition and clinical intuition are useful in promoting competence in professional practice, is there any reason to press for pedagogical innovations in these aspects of reference work? One potential stressor is that online education for the MLIS is becoming increasingly widespread (Oguz, Chu, & Chow, 2018). If intuition is built in part from experiences, the concern is that teaching these skills in a way that does not effectively match the kind of environments where clinical judgment will be refined may truncate learners' initial intuition and erect barriers to developing the metacognitive skills needed to promote career-long service improvement. This concern is in line with Hartman's (2001) observations that both too much instruction and too much reflection can lead to impairments of clinical judgment. When instruction takes place in person, the available suite of classroom technologies is not a pressing issue when considering this balance. The same cannot be said for online instruction for reference work, where every interaction is in some way mediated by a technology. While some online programs replicate the live classroom environment, others opt for asynchronous content delivery. Asynchronous content delivery of instruction materials, video, and other learning objects may remove barriers of access to education, such as allowing adult learners to remain in their current job and supporting the learning needs of a broader array of learners than traditional instruction (Johnston & Karafotias, 2016, p. 235). Where asynchronous delivery of content creates extra challenges is in cases when courses include little live instruction time. Live instruction provides opportunities for active learning exercises. An example of this is live "see one, do one"–style demonstrations of each stage of a reference transaction. These provide opportunities for immediate feedback for ad hoc rules. Instructor-led demonstrations can be supplemented with live-partner and small-group practice. Recorded demonstration videos or peer-led group

work at first seem like equivalent substitutes, but until a certain level of mastery is achieved, real-time feedback remains an important part of building up clinical intuition, and that is difficult to provide without something like a live, interactive classroom. This observation is not meant to be a critique of this mode of educational delivery, which has many advantages. It is only meant to convey that dynamic, interactive capabilities are more challenging to teach using methods where practice is separated in time from constructive feedback.

As part of unpacking what is challenging about teaching the reference transaction asynchronously, it is important to consider both what instruction in this mode may select *against*, (e.g., opportunities for rule testing during full-sensory, real-time interactions) and what is selected *for*. Clinical judgment in the healthcare setting includes knowledge derived from research and from experience. In the same way, clinical judgment in reference work does rely on possessing a baseline understanding of foundational writings, professional standards, and emerging research on reference. Surveying information resources is another useful activity that builds up cognitive understanding, and, as described by Adkins and Erdelez (2006), discussion of reference sources and student exploration of them have long been used as part of reference education. Additionally, providing a list of prewritten questions to practice sample searches is an excellent way to practice search-string construction and to increase familiarity with databases and other searchable tools. These and similar exercises are readily accessible to students learning in the asynchronous online mode. All of these provide valuable domain knowledge, so focusing on them may seem like teaching reference work skills. What is missing is the initial uncertainty, the give-and-take negotiation at each step of the transaction, that is part of satisfying the information needs of another person. More than just the so-called soft skills, such as welcoming, listening, asking open- and closed-ended questions, and other interpersonal aspects of reference, students developing their clinical intuition benefit from opportunities to form and test rules and to refine them based on practice outcomes. Without the opportunity to test rules, there can be no metacognitive reflection on how to improve those rules. This runs the risk of leaving students to learn clinical judgment on the job.

Unpacking the reference transaction

The argument to this point has been that online asynchronous education creates additional challenges in providing a well-rounded reference education and so calls for creative solutions to these challenges. Focusing on the creation of clinical intuition and metacognition as areas for innovation requires a closer examination of the parts of a reference transaction to see where rules testing takes place and where opportunities for metacognitive reflection reside. Many of the skills associated with a successful reference encounter are behavioral, as described in the Reference and User Services Association (RUSA) Guidelines for Behavioral Performance of Reference and Information Service Providers (ALA, 2013). Competency in other skills requires social proficiencies as outlined in RUSA's Professional Competencies for Reference and User Services Librarians (ALA, 2017). Competency documents such as these are useful because they set performative expectations and act as process documents, outlining the expected steps in a reference transaction. Turning again to the medical profession for guidance, we see that competency documents are used in teaching clinical reasoning

(Ryan & Higgs, 2008, p. 379). From these competency documents, an understanding of the reference transaction as a multi-stage practice emerges. Each stage is marked with different opportunities for rules testing. While each encounter is different, operating from a baseline understanding of the expected sequence of activities is a useful shared starting point for learners developing a clinical intuition for reference work.

In addition to being multi-stage, leading a reference interview is a complex skill, meaning that its cognitive, behavioral, and social competencies are not used serially but work together in parallel. Cognitive dimensions include a functional understanding of LIS-centric practical knowledge such as how information systems work, the nature of metadata records, source-specific search strategies, the roles of limiters and operators, identifying reference sources, and many other competencies. Behavioral dimensions are those that involve observable actions undertaken by the reference worker. Examples of these behaviors include body language and other welcoming behavior for face-to-face encounters, checking in verbally or textually to show active listening, screen sharing to introduce resources and teach search skills, assessing patron satisfaction at the close of the encounter, and following up with resources in keeping with the nature of the consultation. Social dimensions include interpersonal skills related to the reference interview, using open and closed questions, avoiding jargon or specialist language, and being mindful of sensitive or ethically challenging topics. While it may be evident that cognitive competencies benefit from rules testing and reflection, behavioral and social competencies likewise provide opportunities to refine judgment of what works and what does not.

Types of reasoning in reference work

Beyond the use of standards documents, it may be useful to introduce a categorical, conceptual model to help reduce the many different tasks associated with reference transactions in a more streamlined way. This is particularly useful when attempting to instill clinical intuition in a course where reference instruction is only one of many information literacy goals. The categorical approach recommended here is a process for simplifying teaching introductory rules testing for reference work by reducing rules to the kind of reasoning they employ: abductive, deductive, and inductive reasoning skills. While it is initially abstract, learning when and how to use each type of reasoning provides beginning learners with a toolkit of testing rules that also helps to shape metacognitive awareness through reflecting on how judgments were reached.

Deductive reasoning

Deductive reasoning is reasoning derived from the application of fixed principles. Drawing deductions proceeds from the ability to make logical inferences from statements that are already known to be true. This is an important reasoning skill for searchers still developing intuition about choosing the range of resources that are available. Becoming accustomed to using deduction helps the learner recognize when they are relying on inferential knowledge, for example, inferring kinds of information that are available in an atlas versus a handbook, or inferring when a time-sensitive source is needed based on the parameters of a patron's question. Active-learning exercises that focus on classifying types of information resources

by function and use that classification to deduce the preferred type of source to obtain an answer teach students to recognize and employ deductive reasoning. A source may or may not exist, and the learner may or may not have access to it, but this categorical understanding of optimal sources gives learners a place to begin based on inferences of which kind of information system is likely to return a source of that type.

Inductive reasoning

Induction is critical reasoning based on evaluating accumulated evidence in an observation-based way. Induction is used during each stage of a reference transaction in order to challenge preconceptions and to test already formed ad hoc rules whenever new evidence is present. Becoming comfortable with inductive reasoning allows students to evaluate search results experientially, overcoming prior inferences that may prove to be incorrect. As an active-learning exercise, using keywords, subject terms, and available limiters and filters to adjust the pool of results, the searcher notes which combinations best produce the needed results. Unlike the hypothesis testing done in the reference interview, where some degree of intersubjective inference will always persist, the evidence of the search-results pool is immediately visible, allowing for rapid revision and testing of a given ad hoc rule.

Abductive reasoning

Abduction is reasoning used to form and test hypotheses. Hypotheses are formed as a result of prior experience and knowledge and tested in practice. One active-learning exercise associated with abductive reasoning is formulating a patron's tacit research question. This is the question that, once articulated, adequately summarizes their information need. Abduction captures the constructive nature of understanding and encourages the recognition that a learner's best understanding at any given moment is subject to iterative revision. This is true as a reference interview progresses and between practice opportunities. Rachel Ivy Clarke (2018) provides an in-depth discussion of the importance of abductive reasoning skills in library practices.

Teaching intuition for the reference transaction process

Now that we have discussed the multi-stage, complex nature of the reference transaction and ways to reduce the many competencies involved in reference work to three reasoning skills, what features should instruction for clinical intuition in reference work contain? Experiential Learning Theory (ELT), as detailed in Kolb and Kolb (2009), emphasizes giving students sufficient opportunities to internalize and personalize relevant learning processes; this takes place through engagement with dialectics of action/reflection and experience/abstraction. Here ELT provides guidance for instructional design for building clinical intuition and metacognitive reflection in an integrated way. In this context, the term *dialectic* is used to represent a back-and-forth evaluative process where each new decision builds on the prior one and forms the next. The dialectic of action/reflection encourages instructors to use active-learning exercises with corresponding opportunities for reflection. These may take the form of self-reflection, peer evaluation, or both. This dialectic between acting on and contemplating the outcomes of an action is very similar to the way in which

metacognitive reflection informs intuition. This process is iterative, where implementing the new intuition provides opportunities for further testing that focuses on questions of which practices did and did not work well in relation to instructor expectations of a baseline competency. The second dialectic, that of experience/abstraction, encourages the instructor to provide opportunities to summarize those reflective lessons from the previous dialectic in their own words and use the products of abstraction, such as what has been learned through engagement with the products of research, to articulate a formal hypothesis about why a particular activity worked or did not work. The output of this dialectic mode is a literal form of rule creation, a key step in forming critical judgments. Once a rule has been created, it should then be implemented in practice, reflected upon, abstracted, and recapitulated as a refined version of the rule.

This dialectical instructional design process provides students with rich opportunities for active-learning experiences, but even these are fully useful only when some mechanism for providing timely and rule-specific feedback is possible. Providing critique in a timely manner promotes intuitive learning by linking internal feedback processes—metacognitive awareness of self-perceived quality of task performance—with external feedback: instructor guidance toward a learning outcome (Narciss, 2008, pp. 130–131). Ideally, this would take place not just in grading of predetermined skills as defined by competency documents but also through feedback specifically for the rules learners have created. As discussed above, examples of traditional active-learning exercises for reference instruction include live demonstrations of each step of reference interviews, live exercises where students choose reference sources or other information sources based on provided questions, and student-led search demonstrations, either with the instructor or with another learning partner. These exercises satisfy the action/reflection dialectic by providing an opportunity to perform the relevant skill, paired with individual or collective critique on that attempt, and the experience/abstraction dialectic by giving them personal practice with which to contextualize class readings and professional guidelines in ways that make sense to them. However, as previously suggested, in classrooms where content is delivered without as many opportunities for interactive learning or when feedback is provided only later and in a different mode than the activity was originally performed, alternative active-learning exercises are worth considering. The remainder of this article focuses on the use of investigative video games as a way of reinforcing reasoning skills that takes advantage of the benefits of ELT dialectics.

Investigative video games as an active-learning exercise

For classrooms with limited reference transaction–related activity time, either because of the content delivery mode or the number of semester-hours devoted to reference work in a larger information literacy–related course, it may be worth exploring the use of commercially available video games that feature investigative themes as a way of fostering intuition through ELT approaches built into games of this type. While this may seem like a leap outside of the context of educating for the reference transaction, prior work by Cohen and Portney (2006) provides an argument for the utility of video games in teaching complex decision-making skills. Further, Nicola Whitton (2009) makes a case for using games in

higher education based on their interactive nature and appeal to adult learners who seek an autonomous learning experience. This is part of a larger tradition of using interactive content to reinforce information literacy concepts (Armstrong & Georgas, 2006). Vieira, de Silveira, and Martins (2019) reviewed recent literature on how educational games could promote heuristic decision making. Video games have the demonstrated ability to create immersive simulations where the direct input of a player affects the course of a game and allows players intuitively to use learned skills, while presenting a clear, tangible goal: to complete the game (De Freitas & Neumann, 2009). Video games likewise have the ability to create memorable experiences that can be easily recalled, and they can provide epistemic frames for in-game learning, including skill acquisition (Shaffer, Squire, Halverson, & Gee, 2005, p. 110). Three of the most important advantages of investigative games in this setting are that they may be played autonomously, meaning that they are not time dependent on synchronous class time; they provide immediate feedback on hypothesis testing; and that feedback is delivered in the same mode as the activity of the game. In other words, an investigator knows if their hypotheses are correct if they are succeeding in the objective of the game. In order to understand how investigative video games may contribute to developing reference transaction intuition, it is necessary to understand what these video games are and how they employ the kinds of critical reasoning skills used across domains to test hypotheses.

The term *game mechanics* is used to describe the rules of a game, including how to interact with game interfaces. A video game is considered an investigative one when its game mechanics allow the player to solve a mystery by finding and evaluating clues. This differs from plotted story games that feature the trappings of the mystery genre but where the game mechanics used to advance the story proceed through the completion of dexterity-related tasks. Investigative games often avoid stating their game mechanics, making learning them part of the discovery process. They may even obscure the end goal of the game, allowing understanding of the game's purpose to emerge slowly though gameplay. The use of trial and error is another common feature, with procedural learning and clue generation occurring iteratively. Through these game mechanics, investigative games serve as exercises for creative discovery, encouraging the kind of hypothesis formation, testing, and critiquing that is useful in building intuition for reference and user services work. The interactive nature of these games provides immediate feedback for the learner and does so with a sense of playfulness and visual appeal, which may promote student engagement. Since the mechanics of each game are different, it is useful to abstract how investigation works in terms of categories of critical reasoning and to relate those categories back to reference transaction practices.

Examples of investigative video games

The following is a selected list of commercially available video games that meet the criteria of investigative video games, followed by a discussion of how they use reasoning skills.

Her Story

In Sam Barlow's *Her Story* (2015), the premise of the game is that the player must observe digitized VHS footage of a woman being interviewed for a murder investigation over the course of several days, the footage of which is contained in a database. Some of the videos

have become corrupted to where the player is able to see only the woman's responses to questions, and the different interviews are truncated and split into video clips that span from a few seconds to a few minutes. In order to uncover the truth behind the murder, the player must type key terms into a search engine to access video clips where the word is mentioned. However, the player is limited to viewing the first five clips that contain the keyword. By listening to the woman's responses in each video clip, the player may glean new information that may yield more results in the search engine, and thus piece together the events of the murder.

Return of the Obra Dinn

Lucas Pope's *Return of the Obra Dinn* (2018) is a puzzle game that heavily relies on log-ic-based skills. The premise is that an East India Company's missing vessel, *Obra Dinn*, has reappeared, but the entire crew and passengers are found to be either dead or missing. However, the player has a mysterious compass that, when approaching a corpse, takes them back in time to the moment of death. The moment is prefaced with an audio clip of the final words spoken in that moment, and then the moment is frozen in time, allowing the player to move about the ship to observe every detail, such as the people who were present, where they were, and what they were doing. There were 60 people on the ship, and the player has to identify each one by name by cross referencing a ship's log of the crew and passengers, along with a sketch. The player also must decipher the ultimate fate of each person: how they died, or, if they lived, where they are now. The moment of death for each corpse in the game is divided up into chapters. The player must discover clues to determine what happened by progressing through the plot in a non-linear fashion, so some chapters might be discovered out of order.

Subserial Network

Penelope Evans and Matilde Park's *Subserial Network* (2018) is an experimental work of interactive fiction that presents itself in the form of multiple application windows that ap-pear on the player's desktop computer. The player exists in a dystopian world where Earth is populated entirely by synthetic beings that are directed to emulate humans as closely as possible by an authoritative being called The Machine. However, there are seditious syn-thetics, termed Subserials, that desire to augment themselves in order to directly connect themselves to The Net, which is analogous to the Internet. The player has been recruited by a government organization to search The Net to discover the online communities of Subserials and turn them over to the government. This goal is accomplished by using a search engine to discover websites of online communities and chat rooms where the player might contact certain synthetics by email.

Abductive game mechanics

Abductive reasoning uses iterative hypothesis testing based on best available information, allowing for useful inferences when not all necessary information is available. One example of this use of reason in an investigative video game are moments in *Return of the Obra Dinn* when a person's death is not observed, so the players must hypothesize about the sequence

and cause of death. The game contains scenarios that are divided up into chapters. Since each scenario presents a frozen moment in time, there can be a short time gap from one character's death to another's. If the player is trying to discover the fates of crewmembers A, B, and C, the scenario might portray Crewmember B being speared, and the player might observe that Crewmember A appears off the side of the ship above the water. The player sees no corpse for Crewmember A, yet Crewmember A disappears between Crewmembers B's and C's deaths. The player might make the supposition that since Crewmember A was suspended over the water in one chapter, then disappears in the next, Crewmember A fell into the water and therefore perished by drowning. There is no empirical evidence to determine that drowning was the cause of death, but the hypothesis explains the disappearance of Crewmember A. This abductive reasoning process parallels how students learning reference interview skills can piece together the user's tacit question though observation, interaction, and inference.

Deductive game mechanics

An example of the use of deductive reasoning in gameplay can be found in *Subserial Network*. During the course of the game, the player must determine the most probable location of the communities where Subserials gather. Players can deduce those locations by creating for themselves a set of decision-making rules to apply consistently. For example, if the player receives an email from a synthetic being who provides a link to a community chat room, and the player suspects that the synthetic is a Subserial, then it is probable that the community for which the chat room is created consists of Subserials. The rule would be if you can prove the Subserial status of the sender, you have reason to suspect locations they recommend. This construction of gameplay rules from principles parallels the construction of the rules beginning searchers creative for themselves about where to begin a search.

Inductive game mechanics

An example of inductive reasoning in an investigative video game is the clip selection mechanic in *Her Story*. At the beginning of the game, the search term "murder" is prepopulated in the database search field. Underneath, there are video clips that all have the word "murder" spoken in them. Experimentation leads the player to the understand that if they put another word in the database search, it may yield a video clip if one of the game's clips has that specific word mentioned in it. Since no more than five clips are viewable for a given term, players must use synonyms to gain access to other clips. This kind of retrieval through trial and error parallels how beginning searchers learn keyword searching. The presence or absence of clips serves as external feedback to give players a sense of how well they are using the search interface.

Discussions, limitations, and conclusions

The value of investigative video games as an interactive, simulative experience is that they are not passively consumed but require the active cognitive engagement of the player. They employ ad hoc rule testing, provide immediate feedback for those rules, and may provide

opportunities for reflective dialectics. If the games lack such opportunities, it is important for instructors to build into any assignment using games reflective exercises for articulating which rules worked well, and why they did. These kinds of games can be frustrating, much in the way that learning how to search or conduct a reference transaction can be frustrating, but when the mechanics and goals emerge, they reward perseverance with a sense of earned accomplishment. Cultivating the perseverance necessary to navigate uncertainty and frustration is an essential skill for reference workers. Therefore, if a game is genuinely able to teach reasoning skills and the ability to build intuition through rule testing, it may create moments of the same opportunities for resolving action/reflection and experience/abstraction dialectics in the game as active-learning exercises completed in physical classrooms. Investigative games are not educational games, and they are not the same as live instruction specific to reference work, but they may be useful as a supplement for when those options are not available.

Some limitations for this approach include the need to gain buy-in from students that the types of reasoning discussed here translate well enough to RUSA competencies. The distinction between types of reasoning may not be obvious, so instructors may need to be prepared to provide examples of active-learning exercises of use in library settings to satisfy both of these limitations. Due to the tropes of the mystery genre, violent or upsetting scenarios may be common in investigative games. To avoid requiring students to engage with upsetting material, use of these games should be optional, a means of supplementing student learning rather than being the instructor's only effort to provide active-learning exercises and timely feedback. Efforts to identify or develop games that use investigative mechanics should be ongoing, with preference given to those without violent tropes. Learning critical information literacy practices is an important part of education for reference and user services work, but using games that reflect the norms of the dominant culture may limit opportunities to provide experience with other practices. Likewise, the fantastic or science-fiction elements in some of these games may create a sense of disconnect in some users.

The abilities to conduct useful reference interviews and to construct efficient and effective searches are essential for reference work but are difficult to teach without extensive repetition and opportunities for immediate feedback. Using investigative video games to supplement other active-learning exercises has the potential to close the immediate feedback gap caused by the shift to online education for the MLIS. The current research is conceptual in nature, and additional research is needed to provide evidence that using investigative video games facilitates the learning of reasoning skills and that those skills promote development of intuition on how best to implement, internalize, and personalize RUSA competencies.

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References

Adkins, D., & Erdelez, S. (2006). An exploratory survey of reference source instruction in LIS courses. *Reference & User Services Quarterly*, *46*(2), 50–60. http://doi.org/10.5860/rusq.46n2.50

American Library Association (ALA). (2009, January 27). *ALA's core competences of librarianship*. Retrieved from http://www.ala.org/educationcareers/sites/ala.org.educationcareers/files/content/careers/corecomp/corecompetences/finalcorecompstat09.pdf

American Library Association (ALA). (2013). *Guidelines for behavioral performance of reference and information service providers*. Reference & User Services Association (RUSA). Retrieved from http://www.ala.org/rusa/resources/guidelines/guidelinesbehavioral

American Library Association (ALA). (2017). *Professional competencies for reference and user services librarians*. Reference & User Services Association (RUSA). Retrieved from http://www.ala.org/rusa/resources/guidelines/professional

Armstrong, A., & Georgas, H. (2006). Using interactive technology to teach information literacy concepts to undergraduate students. *Reference Services Review*, *34*(4), 491–497. https://doi.org/10.1108/00907320610716396

Association of College and Research Libraries (ACRL). (2015, February 9). *Framework for information literacy for higher education*. Retrieved from http://www.ala.org/acrl/standards/ilframework/

Badke, W. E. (2020). Working on information literacy concepts. *Online Searcher*, *44*(2), 49–51.

Barlow, S. (2015). *Her story* [Video game]. Microsoft Windows.

Benner, P., & Tanner, C. (1987). Clinical judgment: How expert nurses use intuition. *American Journal of Nursing*, *87*(1), 23–31. https://doi.org/10.2307/3470396

Black, A., & Gabb, H. (2016). The value proposition of the corporate library, past and present. *Information & Culture*, *51*(2), 192–225. https://doi.org/10.7560/IC51203

Butler, K., & Byrd, J. (2016). Research consultation assessment: Perceptions of students and librarians. *Journal of Academic Librarianship*, *42*(1), 83–86. https://doi.org/10.1016/j.acalib.2015.10.011

Clarke, R. I. (2018). Toward a design epistemology for librarianship. *Library Quarterly*, *88*(1), 41–59. https://doi.org/10.1086/694872

Cohen, S., & Portney, K. E. (2006). Practical context and theoretical frameworks for teaching complexity with digital role-play simulations. In S. Cohen & K. E. Portney (Eds.), *Virtual decisions: Digital simulations for teaching reasoning in the social sciences and humanities*. London, England: Routledge.

De Freitas, S., & Neumann, T. (2009). The use of "exploratory learning" for supporting immersive learning in virtual environments. *Computers & Education*, *52*(2), 343–352. https://doi.org/10.1016/j.compedu.2008.09.010

Evans, P., & Park, M. (2018). *Subserial network* [Video game]. Microsoft Windows.

Geraci, A., & LaVoice, K. (2020). New look, same essence: The enduring value of reference librarianship. In D. Zabel & L. Reiter (Eds.), *Envisioning the future of reference: Trends, reflections, and innovations*. Santa Barbara, CA: Libraries Unlimited.

Harris, M. H. (1973). Intuition, research, and the academic library. *College & Research Libraries*, *34*(4), 269. https://doi.org/10.5860/crl_34_04_269

Hartman, H. J. (2001). Developing students' metacognitive knowledge and skills. In H. J. Hartman (Ed.), *Metacognition in learning and instruction: Theory, research and practice* (2nd ed.) (pp. 69–84). Berlin, Germany: Springer Science & Business Media.

Hogarth, R. M. (2001). *Educating intuition*. Chicago, IL: University of Chicago Press.

Holst, R., & Funk, C. J. (2005). State of the art of expert searching: Results of a Medical Library Association survey. *Journal of the Medical Library Association*, *93*(1), 45–52.

International Federation of Library Associations (IFLA). (2012). *IFLA guidelines for professional library/information educational programs—2012*. Retrieved from https://www.ifla.org/publications/guidelines-for-professional-libraryinformation-educational-programs-2012

Israel, S. E., Block, C. C., Bauserman, K. L., & Kinnucan-Welsch, K. (Eds.). (2006). *Metacognition in literacy learning: Theory, assessment, instruction, and professional development*. London, England: Routledge.

Johnson, A. M., Finley, S., & Sproles, C. (2015). Dismantling the reference collection. *The Reference Librarian*, *56*(3), 161–173. https://doi.org/10.1080/02763877.2014.994192

Johnston, N., & Karafotias, T. (2016). Flipping the classroom to meet the diverse learning needs of library and information studies (LIS) students. *Journal of Education for Library and Information Science*, *57*(3), 226–238.

Kolb, A. Y., & Kolb, D. A. (2009). Experiential learning theory: A dynamic, holistic approach to management learning, education and development. In S.J. Armstrong & C. V. Fukami (Eds.), *The SAGE handbook of management learning, education and development* (pp. 42–68). Thousand Oaks, CA: SAGE Publications.

Kuiper, R. A., & Pesut, D. J. (2004). Promoting cognitive and metacognitive reflective reasoning skills in nursing practice: Self-regulated learning theory. *Journal of Advanced Nursing*, *45*(4), 381–391. https://doi.org/10.1046/j.1365-2648.2003.02921.x

Melin-Johansson, C., Palmqvist, R., & Rönnberg, L. (2017). Clinical intuition in the nursing process and decision-making: A mixed-studies review. *Journal of Clinical Nursing*, *26*(23–24), 3936–3949. https://doi.org/10.1111/jocn.13814

Narciss, S. (2008). Feedback strategies for interactive learning tasks. In D. Jonassen, M. J. Spector, M. Driscoll, M. D. Merrill, & J. van Merrienboer (Eds.), *Handbook of research on educational communications and technology: A project of the Association for Educational Communications and Technology*. London, England: Routledge.

Oguz, F., Chu, C. M., & Chow, A. S. (2018). Studying online: Student motivations and experiences in ALA-accredited LIS programs. *Journal of Education for Library and Information Science*, *56*(3), 213–231. https://doi.org/10.3138/jelis.56.3.213

Pope, L. (2018). *Return of the Obra Dinn* [Video game]. Microsoft Windows.

Ryan, S., & Higgs, J. (2008). Teaching and learning clinical reasoning. In J. Higgs, M. A. Jones, S. Loftus, & N. Christensen (Eds.), *Clinical reasoning in the health professions* (pp. 379–388). Boston, MA: Elsevier Health Sciences.

Shaffer, D. W., Squire, K. R., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi Delta Kappan*, *87*(2), 105–111. https://doi.org/10.1177/003172170508700205

Thornton, T. (2006). Tacit knowledge as the unifying factor in evidence based medicine and clinical judgement. *Philosophy, Ethics, and Humanities in Medicine*, *1*(1), 2. https://doi.org/10.1186/1747-5341-1-2

Veenman, M. V. J., Van Hout-Wolters, B. H. A. M., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and Learning*, *1*(1), 3–14. https://doi.org/10.1007/s11409-006-6893-0

Vieira, E. A. O., de Silveira, A. C., & Martins, R. X. (2019). Heuristic evaluation on usability of educational games: A systematic review. *Informatics in Education*, *18*(2), 427–442. http://doi.org/10.15388/infedu.2019.20

Whitton, N. (2009). *Learning with digital games: A practical guide to engaging students in higher education*. London, England: Routledge.