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Gauging Long-Term Knowledge Retention of Forensic Science: A Follow-Up Study of College Students Who Participated in a Crime Scene Simulation

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ABSTRACT

This is a long-term follow-up to a prior study which found that simulations enhance knowledge retention of undergraduate students who had participated in a mock crime scene. Employing the qualitative method, three participants from the original research were interviewed 1- to 3-years later and asked a series of questions relating to their coursework on forensic science. Findings revealed that long-term knowledge of the major theories relating to the subject domain remained stable over time. It was only the responses to questions regarding specific terminology that presented a gradual decline which is consistent with the decay of semantic memory. Furthermore, each of the subjects were able to recall exactly when during the mock crime scene that they experienced or solved the interview question posited. The ability to trace back and pinpoint the task that prompted the learning and reinforcement of the concept is aligned with episodic memory. Overall, the results indicated that classroom simulations improve long-term knowledge retention of forensic science students.

Keywords: Simulation, Applied Learning, Criminal Justice Education, Long-term Memory

INTRODUCTION

It has been well established that simulations result in enhancing student engagement and knowledge retention of course objectives (Byrne, 2018; Silvia, 2012) and are especially relevant to aspiring law enforcement officers by equipping them with skills needed for that job, whether they occur in the physical environment or via the computer; this form of education is invaluable in preparing for a career in police work (Söderström et al, 2019). Simulations are especially beneficial to law enforcement officers as they prepare them for emergency preparedness training (Miller et al, 2014); police crisis management (Uddin et al, 2020); handling of traffic accidents (Nepelski & Struniawski, 2019); and in developing improved police communications services (Greasley & Smith, 2017). Additionally, simulations also appear in different formats from the physical (Byrne, 2018), to gaming activities (Bonde et al, 2014); and role-playing scenarios (Toomey et al, 2020; Ahmadov, 2011). Furthermore, researchers observed that performance on midterm and final test scores improved after the introduction of an active learning method in the Criminal Justice field (Lysne & Miller, (2017). Participation in a real-world scenario develops the skills which are directly transferable to those considering a career in law enforcement, as in the case of a police cadet program (Caro, 2011). Furthermore, police training programs often use role-playing activities to spark problem solving skills which is critical for the position. Referred to as a 'cognitive load', researchers have found that when individuals participate in tasked based learning, a certain amount of mental effort is utilized to accomplish the mission; understanding that load can lead to an improved training curricula for police officers (Mugford et al, 2013).

Knowledge retention is rooted in long-term memory which is a device the brain employs to organize, store, and recall all of cognition. In addition to information stored internally, digital memory further impacts our consciousness by adding a wealth of externally stored knowledge as well (Zlotnik & Vansintjan, 2019). Unlike short-term memory where information disappears in a matter of seconds, long-term memory enables the storage of knowledge to be held indefinitely (Brem et al, 2013). Long-term memory consists of declarative recollections which involves anything that the mind consciously recalls as opposed to implicit memories which occur at the subconscious level such as in the performance of an activity (Camina & Guell, 2017) such as driving a car, one doesn't need a lesson every time. This current research study focused on declarative memory which is divided into two mechanisms: episodic and semantic as originally identified by Tulving (1972). Episodic is



created after a specific life event where the brain stores information based on the time and place of the activity which had some personal significance (Brown et al, 2016) and unlike semantic memory which consists of common knowledge such as names of places, facts, and terminology that is often memorized. The underlying difference between the two mechanisms is that episodic memory can be traced back to a source or event, while semantic is more wide-ranging in its origin (Brem et al, 2013). Although separate and distinct, the two mechanisms, episodic and semantic, often work in tandem to support storage of long-term information (Duff, 2020) and is sometimes referred to as a "scenario construction" (Mahr & Csibra, 2018: 3). Here the two continuously combine and augment trace memory into storage for later recall but is dependent on the role or reason for its retrieval. In a scenario construction, episodic and semantic are not mutually exclusive, by linking each together knowledge retention is strengthened.

Long-term knowledge relies on a cataloging system which organizes and classifies memories (Klein, 2014; Michaelian, 2016) where it tags the information collected through encoding which in essence provides labels to properly store and recall the data. Depending on several different influences, (i.e.: emotional, spatial, temporal, and general awareness), the longevity of the memory is reinforced with the encoding process (Brem et al, 2013). Encoding is constantly evolving and building upon information, reflections, and perceptions all for the purpose of retention and retrieval (Meena & Kumari, 2018). To further enable recall of information, the amount of attention given to the experience or mindfulness bolsters the retrievability. Paying attention to the stimuli often results in a sharper and deeper memory (Brown, et al, 2016).

Sometimes however, individuals forget things or remember something incorrectly which can result in storage decay, and like a computer, memory is not infinite. Although human memory is an amazing system, it also is an imperfect one. Information declines or disappears due to limited storage space requirements, but also because of the inability to recreate every detail from the original source (Meena & Kumari 2018). Encoding does help storage which assists the mind to remember, but not everything which impacts knowledge retention is saved. The more traces of memory added to the storage aids the duration and stability of that information, but sometimes it gets the information wrong or is incomplete (Meena & Kumari 2018). Often referred to as an imperfect memory, the findings of Flegal & Reutor (2014) for example, presented how a gist can have a negative impact on memory because it traps false information into the encoding and storage phases. As a result, the stored knowledge can be altered leading to what is termed "fuzzy trace" (Flegal & Reutor, 2014: 702). According to this research, a sole memory that had been created can become jumbled together with an idea, one that has no basis, such as from a person's imagination or a suggestion. This results in improper encoding which leads to a false memory. Interestingly, research by Shaw (2020) found that individuals who experience false memories typically cannot tell the difference from the real memory while other studies uncovered the opposite, that true memories have distinguishable characteristics (Jou & Flores, 2013). False memories are often created intentionally as "one might try to forget, avoid, or suppress the memory, distract themselves, substitute a positive memory, or reinterpret the memory", (Samide & Ritchey, 2021: 849) and sometimes false memories can occur from physical over-exertion (Dilley, 2019). Thus, a variety of neuro-cognitive processes enables the brain to sort through information to ascertain which was the correct memory (Straube, 2012).

As found in the prior research, the incorporation of a simulation in the classroom enhances retention of information over the short-term (Byrne, 2018). College level Criminal Justice students who participated in the applied activity were able to recall the theories and concepts covered with detail and precision at the end of the semester that the activity was initiated. This current research took the next step and followed-up with the subjects from the earlier study to determine the effects of this instructional method on long-term memory retention, years beyond the semester the courses were taken. Thus, the purpose of this research was to gauge long-term knowledge retention after involvement in an applied learning activity. As such, the following research questions were proposed:

RQ1: What types of information is retained over time after participation in a simulation?

RQ2: Is there evidence that mock crime scene itself enhanced knowledge retention?

The first research question sought to identify the kinds of information that decays over time while determining the types of knowledge that is effectively encoded and stored. Answers to this question is beneficial to

instructors because it enables them to reach students who are having difficulty in retaining aspects of the domain knowledge by traditional methods of teaching including lecture, examinations, readings, and writing assignments. A multi-method approach to instruction is recommended to improve engagement and retention of theories and concepts, therefore the results of this research will strengthen the comprehension as an alternative manner to teaching. Question 2 sought to gauge how participation in the hands-on activity itself impacted learning. In other words, were the students able to trace back and determine how they secured that memory during the practicum?

MATERIALS AND METHODS

This research reports on the long-term follow-up to a study which examined how crime scene simulations enhance knowledge retention of college students (Byrne, 2018). In the earlier research the sample population consisted of 50 criminal justice students who were enrolled at the State University of New York Farmingdale State College and were evaluated over the course of three years: 2016- 2018, after participation in a hands-on mock crime scene investigation. This practicum represented a culmination of 10 weeks of intensive study in forensic science. Each student assumed the role of an investigator at fictional crime scene, collected and recorded evidence, interviewed witnesses, identified a suspect, which concluded in a mock trial.

A random sample of three students from the prior study were selected with each representing a different year the course was taken between the same period: 2016-2018. All had received satisfactory grades in CRJ 201 Criminalistics, were not currently working in the field, did not take additional courses on this topic, nor had any involvement with crime scenes after completion of their forensic science course. This insured that their knowledge from class did not change over time and that their responses would be based primarily from their experience during the in-class simulation. Following the previous study methodology, this qualitative research also used a series of semi-structured interview questions which necessitated answers on foundational concepts, theories, and definitions of forensic science that were learned over the semester and applied during the mock crime scene.

Evaluation of the interviews was based on three primary questions involving several major areas pertaining to forensic science. To properly satisfy the inquiry a total of five criteria was used as a method to gauge comprehension and recall of a topic thus, a perfect score would entail answering all five parts of each question correctly. All three interview questions were then assessed based on a point scale of 0-3.5. to measure the level of competence in the area. Zero points indicated no recollection while steadily increasing to the top level of 3.0 points which represented full recall, (3.5 points went beyond the basics and added something not covered in class). Statements made by the participants were referenced to provide an illustration of their beliefs, experiences, and thought processes.

All data used for this research was de-identified, with no link to the subject's name or other identifying information to render the subjects anonymous. Approval from SUNY Farmingdale State College Institutional Review Board was first obtained before undertaking the Subject interviews. Using a form of content analysis, this study coded responses to uncover thoughts and characterizations to probe student insight and reveal underlying meanings in communication. This research also employed tenets of grounded theory to constantly review results, reshape the collection of data and to uncover deeper messages.

RESULTS AND DISCUSSION

The results of this study were quite surprising as knowledge decay in the long-term was not severe. All the questions were met with quality responses, and nothing went unanswered. Only the domain specific technical name or subject matter terminology represented the greatest challenge to the Subjects. Furthermore, despite the duration of time since participation in the activity, the results were apparent, simulations enhanced long-term knowledge retention.

Long-Term- Knowledge Retention: CSI Effect

The first interview question was based on a latent finding uncovered in the earlier study which involved the phenomenon referred to as the 'CSI Effect', which essentially involves crime shows on television negatively influencing decisions of jury members in real life (Hayes & Levett, 2013; Houck, 2006; Kruse, 2010; Mancini, 2013;



and Shelton, 2008). More often than not, when presented with DNA or fingerprint evidence, research has found that jurors are more likely to convict a defendant (Ewanation et al, 2017). As forensic evidence becomes increasingly relied upon in criminal trials, no matter the format whether physical or digital (Spotlight, 2018), jurors' decisions can be impacted by the media. A possible benefit of the CSI Effect include a smarter jury pool as these individuals will have a better understanding of the different types of forensic evidence available and their complexities in collection and examination (Vicary & Zaikman, 2017).

In this research, results indicated that the phenomenon of the 'CSI Effect' had resonated and remained in the minds of the students as they were all still acutely aware of this problem as indicated in Fig 1. Each Subject recalled in great detail about the 'CSI Effect' including the definition, the negative impact as well as demonstrating their knowledge of the topic. Based on their responses, all felt strongly about this issue. Subject#3 even communicated this theory to a friend; *"we were hanging out watching the news and my friend said that all criminal cases should require DNA tests, that's the only sure piece of evidence that a prosecutor would need to convict a person ...I then said that you can still convict someone on evidence other than DNA, I'm still not sure if I got through!"*.

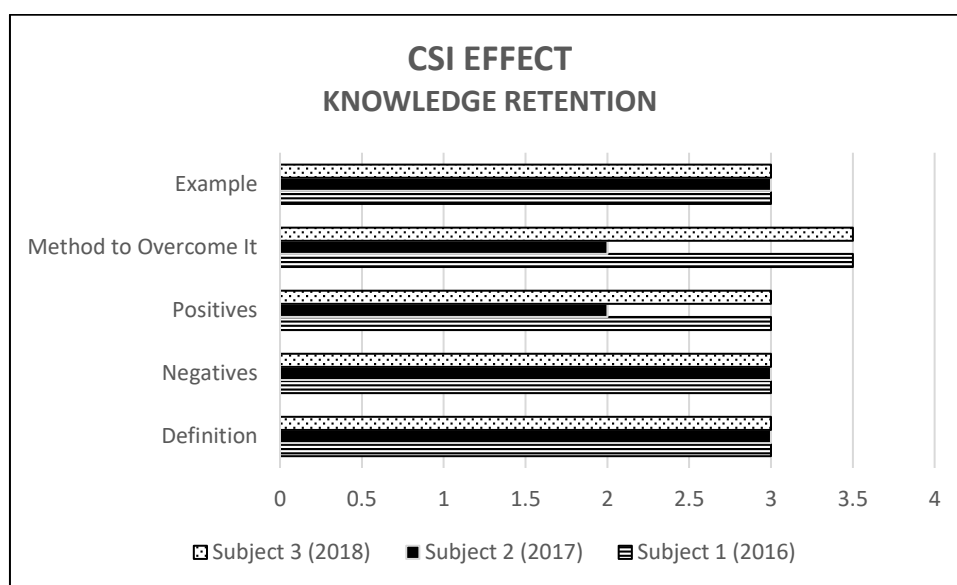


Figure 1: The CSI Effect and knowledge retention

Only when it came to the identification of methods necessary to overcome it and the possible benefits of the CSI Effect did only one student Subject#2 did not fully remember every detail and realized it during questioning: *"I know it's important to overcome the problem of the CSI Effect and it does need to be dealt with to allow for a fair trial...but...I just can't remember how"*.

Two of the subjects showed excellent recall on this topic offered additional methods besides education in the court system thus earning the 3.5 rating; Subject#1 replied that *"high schools should include this in their curricula because unless you take Criminalistics in college let alone attend college, you'll miss out on this important issue"* while Subject#3 stated *"all the TV programs should have a disclaimer telling the viewer that this show is not a reflection on real life or something to that effect"*. This demonstrated the ability recall the knowledge, utilize problem-solving, and critical thinking skills to develop a solution to the question.

All of the Subjects' sufficiently answered the question and demonstrated a good recall of the major issues and definitions of the CSI Effect. One even remembered that this phenomenon played a role in the following mock trial part of the activity which evidences how episodic memory assumes a role in retention of knowledge. By mere participation in an event enabled the brain to effectively encode and store information for future retrieval (Mahr & Csibra, 2018). The student was able to trace back to their individual experience in the activity that occurred many years ago as to how they remembered the issue which enabled them to recall the answer to the question. The results indicate that the broad topic was effectively stored and it was only some of the domain terminology that experienced decay overtime.

Long-term Knowledge Retention: Witness Statements

The second interview question in this study focused on the importance of eliciting witness statements effectively. Many times, little physical evidence exists, and only witnesses can provide the information needed to get to the truth as to what occurred. Eliciting witness observations is of paramount importance however, the techniques that law enforcement officers employ requires a unique set of skills. Soukara (2020) found that police interviewing methods are vital to any investigation and should be utilized by a trained officer however, not every set of circumstances require the same exact procedure. The objective is to get a clear understanding of what was seen and to weed out inconsistent statements or efforts to undermine the inquiry. When the proper procedures are followed a quality law enforcement interview can take place and reduces the chances for deception (Vrij et al, 2007). The National Institute of Justice (NIJ, 2003) offers a free web-based training manual that provides techniques that law enforcement officers utilize to learn how to best manage witnesses to a crime. Five of the steps emphasized in this manual were highlighted in the classroom and tested during the crime scene simulation.

All of the respondents were confident in their answers and knew that interviews play an important role in criminal investigations, see Fig. 2 for an overview of their performance. For the most part, there was no knowledge degradation that occurred for two parts of the questions. Separating witnesses was agreed to be a critical step however, Subject#1 remembered the difficulty of taking-notes during the simulation years prior; *"Note-taking is crucial but be sure not to write down word-or-word what the person says because you will miss key items, as I found out the hard way during the crime scene, I missed so much information"*. Episodic memory was crucial for knowledge recall as evidenced by the participant ability to trace back the memory to its original source during the simulation which occurred years before to answer the question.

Memory decay was apparent for Subject#3 regarding questioning and summarizing aspects of an investigative interview. The respondent was aware of the broader theories and concepts but could not recall specific definitions relating to unstructured and structured questions. This indicates that the semantic memory decayed the most as this was primarily based on general terminology memorized in class. All respondents also agreed on the importance of developing rapport to make the witness comfortable, but the specifics of how-to accomplish this was only recalled by two of the subjects; Subject#1 answered that *"a comfortable witness will talk, and you let them talk and tell their story"*, which contrasts with Subject#2, stated incorrectly the answer because of an apparent fuzzy trace (Flegal & Reutor 2014) *"I know you need to have rapport as a way to quickly record statements, I think...no, I'm sure that's what I did"*. Although the answer was erroneous, it also illustrated the findings of Shaw (2020) that the student was unaware of the problematic encoding which caused an alteration in the resulting false memory.

Obtaining witness contact information and providing the investigator's phone number if additional information comes to mind is another important step in conducting an effective interview. Subject #1 who represented the greatest number of years away from the simulation recalled with certainty: *"Actually I remember handing out my business cards to witnesses at my crime scene so they could call me if they need to add to their statements, and one called my cellphone!"*. This is again in alignment with episodic memory as the student was able to track back the source of the memory to the event. Overall, only Subject #3 obtained a perfect score as it related to interviewing. When asked the reason for the comprehensive knowledge of the subject, the response was, *"I paid special attention and studied hard for the mock crime scene because my goal is to become an FBI agent and interviewing skills are of paramount importance in achieving success in this career"* thus reinforcing the knowledge prior to the experience.

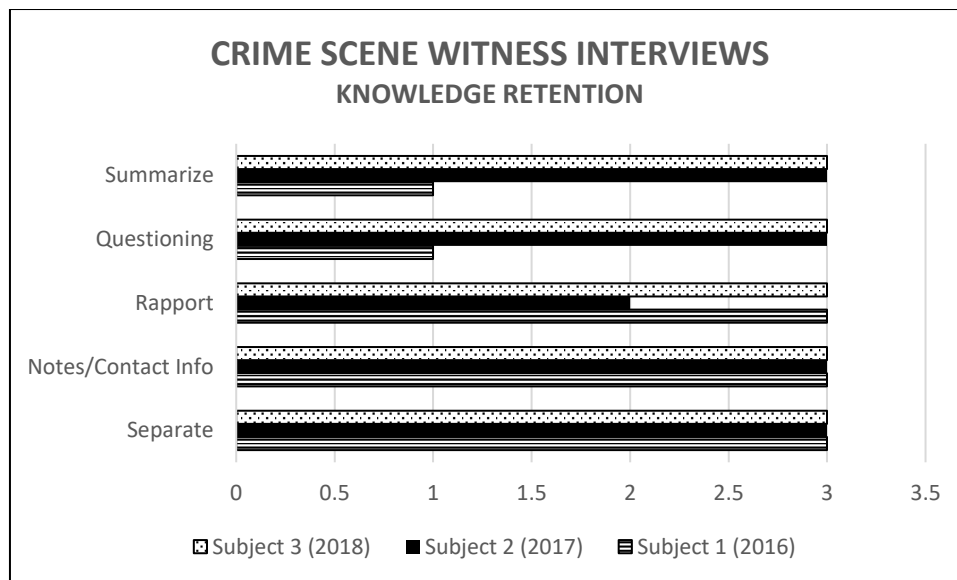


Figure 2: The topic Witness Interviews and knowledge retention

The results of this interview question indicates that long-term recall was sufficient, that the students remembered how vital witness interviews are to an investigation and the majority procedures involved to get the information sought. Semantic memory illustrated the most decay as the recalling of specific terminology declined over time. Furthermore, two students indicated how they precisely remembered certain experiences during the mock crime scene, which occurred years ago, this illustrated the episodic mechanism in improving long-term memory.

Long-Term- Knowledge Retention: Crime Scene Documentation

The final interview question of this study involved documenting the crime scene and its importance to the investigation. "Investigators have only a limited amount of time to work a crime site in its untouched state, the opportunity to permanently record the scene in its original state must not be lost. Such records not only will prove useful during the subsequent investigation but also are required for presentation at a trial" (Saferstein, 2018: 34).

Again, all the subjects were able to recall the major aspects of the topic including major theories surrounding the domain as Fig. 3 detailed. One of the methods to document a crime scene is via photography or videography as one participant accurately noted that photographs require different perspectives; *"I remember taking photos at the mock crime scene, first I took one of the entire area and then slowly got closer to each piece of evidence, down to the scale and marker"*. Episodic memory was responsible for this knowledge to be recalled because the student was able to identify the origin of the information at a particular point in time and recall how it was applied during the simulation. In alignment with semantic memory, the associated definitions were recalled as well. Both mechanisms, episodic and semantic in this instance, worked together and supported "scenario construction" as Mahr & Csibra, (2018) had found in their research on long-term memory. Subject#1 experienced the most knowledge decay as compared to the others, perhaps since the most time had passed. *"Note taking is an important aspect, but since I wasn't responsible at my crime scene, I'm not well versed as to when it should begin or end for that matter"*. Episodic memory was instrumental for providing a source to the knowledge and more importantly for the inability to remember the general concept.

The decline in knowledge retention only occurred for the technical jargon which evidenced semantic decay that deteriorated over time. Interestingly, Subject#3, the most recent participant, could not specify the details of a proper sketch of the scene, except that it takes a birds-eye view while the most distant respondent, Subject#1, could recall many more details due to the episodic mechanism of long-term memory: *"I remember the sketch at my crime scene because we used it during the mock trial, it showed where the evidence was in relation to the victim, along with the investigator name and date"*. Keeping a personnel log is another important aspect to documenting, with Subject#1 forgetting the basic procedures. A critical aspect of documenting the scene

revolved around report writing which is designed to summarize all specifics of the investigation. Subject #2 and #3, recalled the most perhaps due to being the more recent participants. One indicated that *"I really hated writing the report, everything had to match up, all the evidence markers in the sketch had to correspond to the photograph numbers and notes, it was a real pain to complete"*. Although the process was disliked, it again illuminated the episodic memory mechanism as the participant knew how they remembered the information albeit in a negative manner. The broader topic areas were most recalled by all the participants and only the terminology experienced memory decay over the long-term.

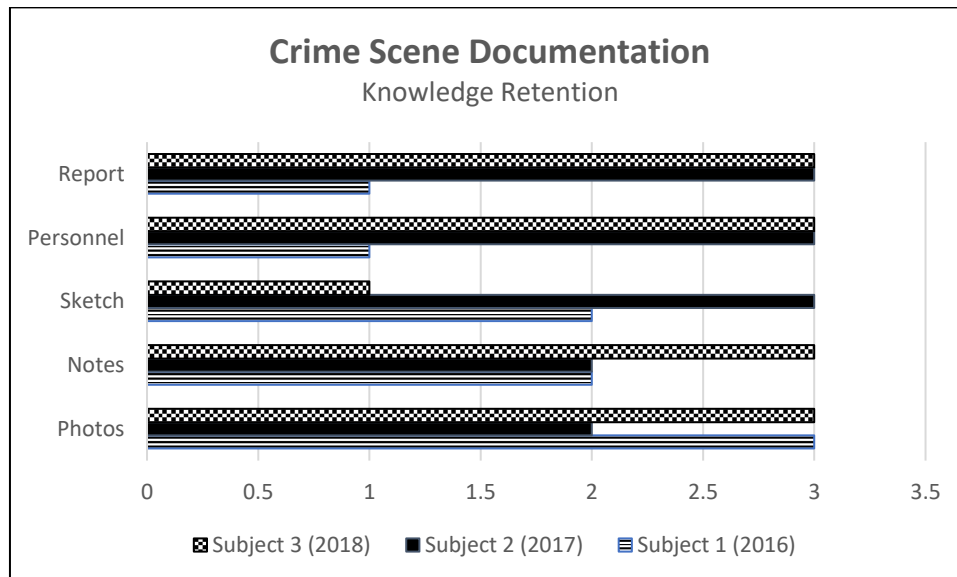


Figure 3: The topic Documentation and knowledge retention

Overall, the results of the third interview question, like the other two suggest that the benefits of a simulation to long-term knowledge retention is a worthwhile endeavor. Memory decay was reflected in a decline in recalling specific terminology however, all comprehension of the course learning outcomes was sufficient.

CONCLUSION

It is apparent that crime scene simulations offer an effective method to improve long-term knowledge retention at the college level. For the most part, an immersive applied learning pedagogy can offer a unique way to increase recall of a topic over the course of many years however, a simulation does not guarantee perfection. As seen in this study, all the participants interviewed did retain a solid comprehension of the coursework but there was also evidence of a decline in information retained that was not limited a specific time frame or one individual.

In response to Research Question 1; the types of information retained via the mock crime scene included the broader topics including the major theories and issues relevant to the discipline. The episodic memory was effectively reinforced by the simulation and the storage remained stable throughout the years. Moreover, the types of information lost included terminology specific to the domain however, not to a great degree. As such, semantic memory experienced the most decay as the participants were challenged by some of the definitions, terminology, and procedures. In Research Question 2, there was ample evidence that the simulation itself directly enhanced knowledge retention. Each of the participants in this research pinpointed to a specific experience during the mock crime scene that made them remember how they knew the answer. This is aligned with the episodic mechanism because a certain event triggered the memory. Overall, crime scene simulations are advantageous to the college level classroom as they enhance long-term memory and offer another valuable tool to the educator.

The limitations will guide future research by seeking a larger sample of participants so the results can be generalized; additionally, a control group will be utilized and comprised of students who did not participate in the simulation to enable a comparison of knowledge retention from the different modes of instruction.

Conflicts of Interest

There are no conflicts of interests.

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Author Biography

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