Augmenting the learning process for 7th graders using visualized memory palaces

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ABSTRACT

Memory techniques exist and have been scientifically proven, time and again, to be very effective. Government schools in Pakistan emphasize rote memorization and private schools (to a large extent) rely on memorization too. Memorization is key to succeeding in the current Pakistani educational setup. Additionally, being able to better remember and later recall the material taught in class is a very useful skill for students to have. Most people are unaware of the existence of memory techniques and those who are aware are not familiar with their real-world applications. The memory technique we have focused on is the Method of Loci (MoL), commonly known as the memory palace technique. The objective of our study is to investigate the results of introducing the MoL to children in a classroom setting and to study the methods employed for teaching participants the MoL. While our results are preliminary, we learned that such a technique has the potential to be effectively used by students as an aid to remembering the material taught in class.

INTRODUCTION

A common misconception regarding memory palaces is that they require prior knowledge and familiarization with the location the palace is constructed in. However, this is not the case. In fact, the daunting task of creating the palace is considered to be the biggest barrier that demotivates people from using the MoL [8]. While the effectiveness of the technique has been consistently proven, it is of little use if people do not use it because they feel that creating the memory palace requires too much effort. This issue holds greater significance for children, who will likely and understandably be put off by the task of creating the memory palace [7]. They would be put off by the MoL entirely unless they feet that it is interesting and fun to use.

We tried to tackle these issues by removing the barrier to entry by creating the memory palace for the children. More specifically, we chose the location, created the images and their association with the things to be remembered and placed them in the palace. We also included audio to further increase the relatability and memorability of the content placed in the palace. We integrated this palace with a PC application that would allow the students to navigate the palace at will. We hypothesized that, if students were given the memory palace, they would be more likely to use it and adopt the MoL as a memory technique. Thus, we conducted a study to examine the effects on learning of introducing a visualized memory palace to students of the 7th grade. More specifically, we compared the performance of students who were exposed to a memory palace versus those who were not. We also looked at the effect that being exposed to a memory palace in a familiar location versus one in an unfamiliar location would have on a student. All of this was introduced to the students in an approachable and simplified way to further increase the likelihood of them responding positively to it.

RELATED WORK

Several studies have been conducted looking into various aspects of memory and memory training techniques. We focus our research of related works on prior papers that review ‘the method of loci’ or the larger field of ‘memory training’. The first of these was Legge et al.’s [1] paper that

focused on several aspects of the Method of Loci (MoL). The authors identified misconceptions about the MoL and their research showed that the MoL is not, as widely believed, better suited to memorize serially ordered information. This result was also backed by the research conducted by Krokos et al. [3]. The authors argued for familiarity with the palace (before inhabiting it) to not be as much of a contributing factor to the effectiveness of the palace. The research also showed that high-imageability words are more easily recalled while making use of the MoL. Visual aids, in the form of images and spatial association made with a physical location [9] significantly aid recall [11], up to 8 months after being exposed to the memory palace [8].

Joshua Foer talks of the effectiveness and legitimacy of memory techniques, especially the MoL, in his 2011 best seller, "Moonwalking with Einstein" [2]. He explains how the physical structure of the mind remains constant through all human beings and the only thing these memory champions (people competing in memory competitions and performing amazing feats of memory) are doing different is that they've studied and understood the brain, familiarized themselves with several memory techniques and trained their memories for extended amounts of time. This was corroborated by an experiment conducted by Ericsson [14]. In his book, Foer discusses the memory-training methods employed by Raemon Mathews in a high school classroom. Raemon, with an understanding of the education system, demanded extra effort from his class to learn and employ memory techniques in their academics. The results were very fruitful; every single member of the class passed the New York State Regents exam (2001 - 2004) and 85% of the students scored a 90 or better. The class consisted of a little over 40 students. Mathews has won several city-wide 'Teacher of the Year' awards for his methods. It is worth noticing that in the neighbourhood Mathews was operating in, 9/10 students were below average in reading and mathematics, 4/5 were living in poverty and almost 1/2 did not graduate from high school [2].

Research conducted by Richmond et al. [4] compared the effectiveness of several memory training techniques in helping remember vocabulary. The pegword and MoL techniques produced better results, on average, compared to other techniques employed by the authors. Zarei et al.'s study also measured differences in effectiveness between the pegword and MoL techniques in help with learning a language [5]. According to their results, the difference between the two was statistically insignificant.

The creation of the memory palace is the most difficult aspect of adopting the MoL technique [8]. Often people are demotivated to use it because of the daunting and confusing task of creating a palace. Levin's paper, reviewing memory techniques in classroom settings (from 1973-1993), concluded that the techniques are most effective when employed with assistance from teachers i.e. when teachers adapt content to the technique for the students [6]. Students, especially those in primary and secondary school, could find it difficult to grasp the concepts behind the workings of these techniques and not be able to properly make use of them or might just be unwilling to put in the time and effort required to employ them. Teachers or experts, therefore, need to take responsibility for producing content and aiding the children. A tool used to better visualize a palace showed that college students found it fun to use [12]. It important to ensure that children find it fun and interesting to interact with the palace.

Finally, the research carried out by Qureshi et al. worked with Pakistani college students and studied the effectiveness of the MoL [7]. The MoL was created by the teachers for the students based on a part of their curriculum. The students showed no hindrance in accepting the technique and, on average, performed better during evaluation than the control group.

We build on the foundation laid by these prior review papers and research in several ways. First, ours is the only study ever conducted on secondary school level Pakistani students. The methodologies we have resorted to in our efforts

to depart the idea behind the MoL to the students is also something that hasn't been discussed in any prior study. Second, no work has been done that makes use of an actual illustrated memory palace that the children can see on a screen. Other studies (including several we reviewed before our work) made use of virtual environments as memory palaces but the markers and reminders used to inhabit them were merely stock pictures and nothing specialized. Third, the format of the session we held to introduce the children to the MoL and have them interact with the memory palace that we designed is also unique. It only took 40 minutes compared to other studies which required several sessions with some even spanning over 2 hours each. In the discussion, we talk about how the effectiveness of our session and the extent to which we achieved our goals. We also discuss the results of the evaluation test we employed after the session to measure effectiveness of our palace. We believe the discussion will be particularly valuable to researchers looking to study memory techniques or augmenting the traditional method of education currently employed in schools.

METHODOLOGY

We used a mixed methods approach for our systematic review. First, we conducted an in-depth survey of literature concerned with memory techniques and memory training over approximately the past 2 decades (mostly due to lack of research done in recent decades). One review paper [6] was an exception to this rule because of its relevance.

The methods we used to search for our papers are as follows: electronic search, where we searched for relevant articles on the following databases: ACM, IEEE, Springer Link, Science Direct and Research Gate. Several variations of the following key words were used: Children, Classroom, Method of Loci, Memory Training, Memory Enhancement, Memory and Memory Technique; screening process, where a total of 51 scientific articles were initially gathered and then screened based on the following criteria:

1. Article should not be solely about how to improve or strengthen the working memory.
2. Article should not be testing the effects of memory techniques on subjects with some disability or medical condition.
3. Article should include the MoL, a comparison of memory techniques or the formation of spatial associations.

Studies exclusively dealing with the MoL were hard to come by so studies working with several memory techniques were also included in the review to gain information regarding how researchers went about familiarizing the participants with the science behind why and how the technique works. Studies working with participants from all age-groups were also made part of the review.

Studies were excluded if they were testing memory techniques from a neuroscience perspective. Such studies had results based on MRIs and different types of brain scans which did not help our cause of studying the effectiveness of the MoL in schools. The included studies present results in the form of test scores from tests that the participants took after being taught the usage of memory techniques.

None of the studies included participants with any illness or disability. Genders of the participants had no effect on the results in any of the studies and has therefore been deemed unnecessary. The age groups varied in all the studies but the results remained more or less consistent; the memory techniques showed effectiveness, some of them more than the others.

After the systematic review, we decided we were going to solely use the MoL as our memory technique. This decision was based on the effectiveness showcased by the MoL in all the papers we reviewed and the nature of material this technique allows to be memorized. Similar to [7], the participants in our case study are Pakistani students. However, they are students of the 7th grade and not college. We chose this because we wanted students to be exposed to memory training and the MoL as early as possible in their education. Also, there is no study showcasing the effectiveness of the MoL on Pakistani secondary

school students using the technique to remember content more complex than just vocabulary. We also wanted to, as in [7], create the content for the memory palace ourselves and not leave that task to the children. Building on top of [7]'s method, once the content for the palace was created, we drew illustrations to actually allow the children to visualize the memory palace and make the experience more interactive. We also wanted to experiment with two different physical locations for the palaces. One was their school, which they were familiar with, and the other was a random house, which they were unfamiliar with.

Creating the Memory Palace

Acquiring Content

We got into contact with a local school and, collaborating very closely with its administration and teachers, decided to create a memory palace based on a chapter from the 7th grade Pakistan history textbook. The chapter was about the life and contributions of Sir Syed Ahmed Khan. We were given a copy of the text book and a question bank by the 7th grade history teacher. The content of the memory palace was finalized after several thoughtful readings of the chapter. Study material in the book was broken down into triggers that could be placed throughout the palace. The question bank was also taken into consideration while designing the palace. We wanted to have as much information as possible being delivered through as little a number of images (or triggers) as possible, in accordance with our assumption that the smaller the palace, the easier it would be for the children to remember.

Creating Illustrations

Once the content was finalized, illustrations were created based on each trigger. Due to time constraints, the illustrations could not be animated as planned earlier. Sounds associated with the illustrations (in order to add an extra layer of memorability) were collected to be used with the illustrations in the final product. A script was also written with relevant text to complement each illustration.

Figure 1: The interface of the application with a video loaded onto it

The Palace

A video recording was made of the two memory palaces to be used. One of the locations chosen to act as the palace was the campus of the school we were collaborating with. This decision was based on the fact that all the students in the school would be familiar with the map and layout of the campus. The other palace chosen was a random house that none of the students were familiar with. This was to test the hypothesis that a memory palace based on a familiar location would be more effective. The videos created of both the sites were walk-through style videos which would give the impression that the person watching the video was walking through the palace (first-person view) and would pause and look for small intervals of time in specific places before moving forward to the next location.

Adding the Illustrations to the Palace

We overlaid the illustrations and the associated sounds onto the video at the locations in the palace where the video would stand still.

The Voiceover

Once the video was composed, the script was voiced. The audio was then spliced and added to the video at the appropriate time intervals.

The Interface

Once the video was completed, an application was created to the play the video. The application's interface (Figure 1) contains buttons that allow students to navigate through the palace. wxPython was used to create the GUI, MPlayer was used to handle the video playback and MPlayerCtrl was

used to wrap MPlayer into wxPython. During use, a screen recording software was used to record screen activity while the children were using the application.

User Study

Participants

A total of 30 7th grade students, aged 13-14, participated in the study. No special criteria were set for the children to be part of the study except that they be in the 7th grade at the school where we conducted our study. The students were all familiar with the use of computers and were fluent in English. Everything was approved by the school administration and the children participated willingly.

The 30 students were divided into two groups: control and experiment. The experiment group consisted of 14 students and was further divided into 2 groups of 7 each: group I and group II. Group I was shown the video of the memory palace based on the campus and Group II was shown the video of the memory palace based on the random house. It was a between-subjects design.

Materials

The lab had PCs with Core i3 processors that were able to easily run our program. All systems had 19-inch 720p LCDs. All the systems had Windows 10 installed. We installed a screen recorder software and extracted our program onto each system a day before the session. A pair of earphones was also connected to each system.

Procedure

We were given only 40 minutes by the school administration because of the students' schedule of back-to-back classes. We divided the time as follows:

(i) 10 minutes: We introduced the students to the concept and workings of a memory palace. Papers that we reviewed made use of several ways to depart knowledge of the memory technique to be used. Richmond et al.'s study entrusted the children with the task of learning about the memory techniques assigned to them on their own over a period of two weeks [4]. Other studies dealt with older, more mentally mature students so we could not use the techniques used in those studies to depart knowledge about the MoL to 7th grade students.

We delivered a very short but precise description of the MoL technique followed by a live walkthrough example. Very simple and layman language was used throughout the session. A paraphrased excerpt from the session is as follows:

"We're going to teach you the memory palace technique. I'm going to walk you through how it works. So, as humans, we're really, really good at remembering places. Imagine you're alone at a friend's house and you spend 5 minutes just walking around the place. After 5 minutes, you'll have a fairly strong idea of what your friend's house is like. What this tells us is that we can very easily remember places. Is everybody with me?". Class responds with a yes. "Okay! So how do we use this ability of ours to learn spaces easily to learn other things as well? Say, for example, a chapter from your history books? You can easily do that using the memory palace technique! Suppose all of you need to remember a grocery list. The first item on the list is a 'mangoes'. Close your eyes and imagine that you are standing in front of the main gate to your house. Now, imagine that, exactly in front of the gate, there's a basket full of mangoes. Try to smell the mangoes. You must remember something about what they smell like. Imagine yourself eating these mangoes. Blow the size of the basket out of proportion. Imagine the basket of mangoes being as big as the gate. Okay, you have that image in your heads now. The mangoes were on your grocery list and you won't forget them now. The next item on the grocery list is 'water

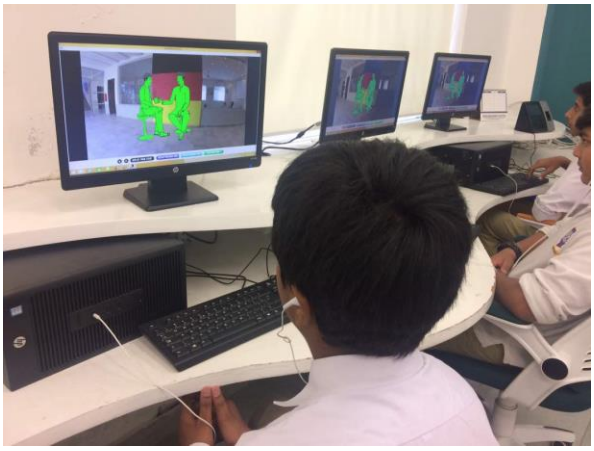

Figure 2: Children using the application during the session

bottles'. Walk through the gate into your house. Imagine there being 2 water bottles with arms and legs and faces, running all over your lawn. You're hungry from the mangoes you just ate and you want to drink some water but the water bottles just won't stop running. See how you assigned crazy features to the water bottles; the arms and the legs? They make them more memorable. Okay, so the next time you guys need to recall this grocery list, just imagine yourselves standing in front of the main gate of your house. You'll see the mangoes. Walk in and you'll see the water bottles too. This is how you memorize. Your houses, in this case, were the palace and you placed markers as you went through them to remind you of things you wanted to remember."

The children responded well to this explanation and seemed to understand it well.

(ii) 5 minutes: We explained to the students how to run the program we had developed. Students were given step-by-step instructions on where to navigate to and where to click to get the program up and running. Anybody facing difficulty was asked to raise their hands for assistance. After ensuring that everyone had the palace setup to the point that only clicking the 'play' button was required to start the video, we moved to the next step.

(iii) 15 minutes: We first asked the students to go through the entire palace once. This took about 5 minutes. Then we told them about the buttons on the interface and what they do. We asked them to go through the palace again and make use of the buttons as they please. For this, the students had about 10 minutes.

(iv) 5 minutes: We distributed a questionnaire based on the Likert scale model and told the students to fill it out.

(v) 5 minutes: We discussed the purpose of the session with the students and had a question and answer session with them.

We anticipated possible issues that the students may run into during the experiment. We decided to keep intervention minimal by intervening only if the student was facing some technical issues. Otherwise, we let them use the application however they wanted to. The students did not seem confused either and easily used the application.

Evaluation method

We used three methods for evaluation: a questionnaire, screen recordings and a quiz.

Using the questionnaire, we wanted to find out how the students felt about the application. We used a Likert scale and asked them the following questions:

Q1: You want to do such an activity in class again because you found it fun.
Q2: You want to go home and practice using the Memory Palace on your own.
Q3: You want to learn other chapters using a Memory Palace too.
Q4: You could understand what the voice in the Memory Palace was saying.
Q5: You found it easy to match the pictures to what the voice in the Memory Palace was saying.
Q6: You found it easy to navigate through the Memory Palace.

For the screen recordings, we used a software to record screen activity. This allowed us to analyse

how the students used our application by looking at their clicking patterns and at the amount of time they spent per part in the memory palace. Only meaningful clicks were looked at so clicks that were repetitive or spam were ignored.

A few days after the session, we quizzed the students. The quiz, designed by us, consisted of questions from the pool of questions given to us by the school. Some questions demanded knowledge directly departed to the students via the memory palace and others demanded information the palace did not cover. The quiz had long questions, worth 3 marks each, that demanded points equal to the marks they carried. The quiz also had fill-in-the-blanks style questions that demanded students to recall knowledge directly delivered via the palace. The quiz was announced on the same day as the session and was held 2 days after the session.

RESULTS

Questionnaire

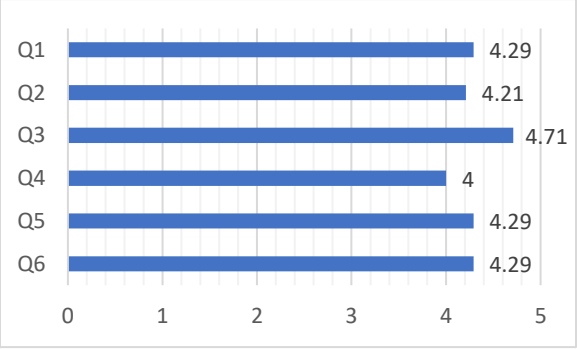

Figure 3: Results of Questionnaire; average of scores on a 1-5 Likert scale

The results of the questionnaire can be seen in Figure 3 which shows the average scores for each of the 6 questions. Overall, students responded positively to our application. The first 3 questions judged the likeability of the application and told us that students enjoyed using the application and were open to its future use. The next 3 questions judged the effectiveness of the palace we created. We learned that the students found the images we created and their mappings to the content that they had to remember relevant and helpful. They also found it easy to move around the palace and look at the images that they wanted to. The students generally seemed excited throughout the session and the results from the questionnaire reflect this.

Screen Recordings

Two things were tabulated by watching the screen recordings: the number of times each button was clicked and the total amount of time spent viewing every part. The latter was then used to calculate the number of times each part was viewed so that they could be compared because each part had a different length. This was done by dividing the total time spent viewing the part by the length of that part, which included its audio and image both. The results are displayed in Tables 1 and 2.

The results showed that students were active in using the application. All students used the buttons to navigate around the palace and see the images at will. The average number of buttons clicked per student was 12.23 and the average number of times each part was viewed per student was 1.7. These numbers showed that the students interacted with the application well given the time that they had. The students were not afraid to experiment with the application to see what they can do with it. The 'Play next' button was the most popular one that was used to navigate the palace.

Furthermore, the analysis of the videos revealed two main usage patterns among the students. The first was the students clicking more to navigate the palace and, consequently, spending lesser time on viewing the images. The second was the students clicking less and, consequently, spending more time viewing the image and listening to the audio that accompanied it. A third pattern of usage that was seen in only two students was spending the majority of time on just one part as if the student had chosen to memorise that one part completely over trying to memorise all parts the best they could.

Quiz

Attendance for the quiz was low because students were absent. Only 8 out of 14 students from the experiment group were present for the quiz as well. 12 students from the other section of grade 7 (Section A) were used as control. Furthermore, 3

Play	Pause	Replay from start	Replay previous	Replay current	Play next
41	21	11	17	15	54

							Last One
Time (seconds)	355	639	1084	635	436	1009	622
Number of times	1.49	1.98	1.43	1.42	2.08	1.68	1.48

Table 1 (above): Total number of clicks per button calculated from the usage of all the students
Table 2 (below): Total amount of time spent viewing each part and the number of times each part was viewed

students of Section B who were supposed to be part of our initial session and were absent but were present for the quiz were considered part of the control group.

Despite the low attendance, the results were promising. The mean marks, out of 13, for the experiment group were 5.86. The mean for the control group was 0.75. This shows that the students exposed to our application did significantly better on the quiz. Hence, even though the number of the students was small, the results were promising and can be built upon.

DISCUSSION

Low Number of Students

The total number of students that we had expected to have for our experiment was 40. They were to be divided into two groups of 20 which we would use for our session and as our control group. However, the number of students that actually attended was very small. Only 14 students were present in school on the day of our session and that number decreased to just 8 for our quiz. The low attendance numbers also caused a mismatch in the numbers of people in the control and experiment groups, affecting our ability to compare results between the two. Furthermore, they also disallowed us from comparing the difference in ability to remember of students who were exposed to a familiar location in the palace versus those who were exposed to an unfamiliar location. All this greatly affects the validity and generalizability of our results and impedes our ability to draw conclusions from it.

We learned that in order to carry out this experiment successfully, we need to ensure proper attendance of the students through the school. Given that we have no control over the students attending school, coordination with the school is the only way to go. Another option would be to offer material incentives to children for being part of the session. However, given the nature of our application and the setting for our experiment, using official school channels is a far better option. More importantly, incentivizing one group of children to attend the session would highly demotivate the other group, introducing a bias into our experiment that would render the results futile.

Effectiveness of the Palace

The questionnaire provided us with some key insights about our memory palace. We were concerned that presenting the students with a palace that we had created might make it difficult for them to use it effectively. However, we learned from our systematic review that using spatial associations made by others does not affect the effectiveness of the MoL and this was echoed to us by the students as most of them did not have any issues matching the images used to what the voices were saying. Furthermore, they all found it easy to navigate through the palace, actively doing so

using the buttons available to them. They did not have any issues with the possible unfamiliarity with the location, with the route taken through the location or both.

It being the first iteration, we were satisfied with the overall quality of the memory palace we created and with the level of interaction that students showed with it. We would have liked to give the students more time to explore it but time constraints disallowed us from doing so.

To make the content being presented in the memory palaces more memorable, certain techniques were made use of. Information was manipulated in the following ways:
(i) catchy rhymes were associated with it
(ii) it was made part of a narrative
(iii) a visual element was added to the text to make it stand out.

For their answers in the quiz, the experiment group showed clear signs of remembering several pieces of information because of the manipulations made to it in the palace. For example, in the palace, there's this image of a huge red book with its title, "Tabian ul Kalaam", printed on the cover. Only, Tabian ul Kalaam is written as follows: "TaBIAn ul Kalaam". In the voice-over, the students' attention is directed towards the out-of-place and uppercase BIA in the name of the book. They're then told that this is supposed to remind them of the British Indian Association that was also one of Sir Syed's initiatives to bridge the gaps between the Muslims and the British. The quiz asked the students for the name of the book and the organization. All students from the experiment group wrote the BIA in Tabian ul Kalaam in uppercase and drew from that the name of the British Indian Association. This highlights the effectiveness of the visualized MoL. This is something not quite achievable using the traditional mental MoL.

A Fun Activity

The teacher who taught the class whose material we used to build our memory palace told us that an activity like this will always be welcomed by the kids because it allows them to depart from their mundane school activities. The kids showed this throughout the session too as they were enthusiastic to take part, speaking up when we asked them questions and quietly using the application when we asked them to. Introducing the students to the MoL as a memory technique that is both effective and fun is a key aspect of our experiment. Our questionnaire showed that the students responded positively to being introduced to such a technique. They claimed that they had fun and would be open to more activities of the sort in future. In fact, the most positive response by the students on the questionnaire was to the question that let them express their willingness to learn other chapters using a Memory Palace too.

These results are not without caution, however. Given the overtly positive response of the students, we were concerned that they took the MoL activity as more of a leisure activity than as something they should use as an aid to help them perform better in class in addition to finding it fun. While it is hard to quantify the measurement of such a metric, there are measure that we can take to better assess the students' interaction with the memory palace. We can widen the scope of the questionnaire to be able to more accurately gauge the response of the students. Furthermore, we can work with the school who can communicate the importance of the activity to the students a day or two prior to it. This would associate the activity with the school to a greater extent so perhaps students would be inclined to take it more seriously.

FUTURE WORK

We learned many things from our pilot run of introducing the MoL to a classroom setting. The results, while they have their limitations, show enough promise to encourage further pursuit and refinement of this work.

To truly understand the effectiveness of the MoL in classrooms, we would have to run a more detailed experiment. Ideally, we would introduce the technique to students at the beginning of a semester or term for one course or subject and consistently hold sessions to encourage its use as

an aid in the classroom. This would require the construction of multiple palaces with varying content for each of the chapters that is taught in class. The students will be exposed to each of these palaces depending on when the chapter is taught in class. The performance of the students will be judged using quizzes and exams that will be taken by both the experiment and the control group. This will allow us to make valid and conclusive statements either in favour of or against the use of the MoL as an effective aid in helping students remember material taught in class.

The key elements here are a more detailed and reliable experiment and multiple palaces with more diverse content, encouraging students to use them more consistently. The palaces can be built using the same technology that we used in our pilot run.

CONCLUSION

In this paper, we introduced the Method of Loci (MoL) to a classroom by creating interactive memory palaces that students can navigate around on their own. For our pilot run, the scope of the palace was limited to one chapter from the History textbook. The students were encouraged to use the palaces to help them remember the content of the chapter better. We ran into problems with our experiment that prevented us from making conclusive statements about the effectiveness of introducing the MoL in a classroom setting. However, the preliminary results are very promising. Firstly, they quantitatively showed that the students exposed to the memory palace performed better on the quiz. Secondly, they showed that the students found the activity fun and were open to future use of the MoL. One of the students even suggested using this to learn languages after being exposed to the mix of audio and images that we used in our palaces. The results encourage future work with using memory palaces in classrooms as an aid to classroom learning. The MoL has the potential to be a technique that the students can regularly use to help them better remember the material taught in class.

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