

## CHAPTER V

### ANALYSIS AND DISCUSSION

#### 5.1 Introduction

In this chapter of thesis, it stated the experimental analysis of the findings. Then, it exemplified how statistical test and analysis were conducted on data before the findings were discussed.

#### 5.2 Analysis

In this study, there were two types of analysis employed such as; memorization time and error propensity. Hypothetically, both of them can be stated mathematically (Figure 5.1) (Katkov, M., et al., 2014; Gagl, B et al., 2015; Barton, J. J., et al., 2014; Hojjati, A., et al., 2014). The measure taken from analysis was based on the repeated measures imposed. In other words, if  $X$  was a precise measure consisting of  $X_1 \dots X_N$  repeated measure, at that time their average  $\bar{X}$ , was taken as the real value of  $X$ .

From the formula, it was quite apparent that the analysis rotated around the performance of the members in memorizing a specific Quranic content (Ariffin et al., 2013 ; Moore, 2008) within a fixed amount of time and their capacity for successful recall (Klein et al., 2005). This provided a more encompassing view on the efficacy of the proposed model, particularly on the overall speed of encoding new information into memory (Johansen, 2008); in addition to the accuracy of retrieving it back when prompted.

Figure 5.1: Formulation for corrected letter in quran memorization

N = Total Letters	
R = Number of Repeated Measure = 3	
X = Correct Recitation of Letters	
T = Total Time	
$X = X_1 \dots X_N$	
$X = (X_1 + X_2 + X_3) / R$	
Memorization Time	= $T / X$
Error Propensity	= $(L - X) / L$

Practically speaking, memorization time was defined in this research as the time required by the participants to commit a letter into memory (Mainy et al., 2007), a form of sequence learning (Fu et al., 2013). To be specific, it was measured by dividing the time given for memorization with the accurate number of letters recited by the members from memory. This was a crucial aspect due to the fact that a better memorization technique (Astuti, 2015; Lai, 2005) resulted to a faster rate.

For the purpose of illustration, consider the setting given below (Figure 5.2); supposed that the total of five ayat accumulated to 100 letters. The participant was allowed to indulge in memorization for 3 minutes or 180 seconds. After memorizing the intended content, that person was tested three times. As such, the average number of correct recitation was taken as the representative data.

Figure 5.2: Example of Memorization Time

Total Ayat	: 5
Total Letters	: 100
Correct Recitation from Memory	
Repeated Measure 1	: 95
Repeated Measure 2	: 93
Repeated Measure 3	: 98
Average Letter	: $(95 + 93 + 98) / 3$ : 95.3333
Total Time	: 180
Memorization Time	: $180 / 95.3333$ : 1.8881 : 1.8881s to memorize one letter

The memorization time in the aforementioned example was 1.8881 second. This simply implied that the participant took 1.8881 second on average to memorize a letter from the Quran. Lower memorization time was favorable over higher ones because it signified a higher capacity over time (Luria et al., 2010; Cowan, 2008), especially from the perspective of encoding speed (Wilms, Petersen & Vangkilde, 2013).

The other measurement was error propensity, which denoted the probability of the participant in making an error in memorization (Orzel-Gryglewska, 2010; Atkins, 2009). The same data can be harnessed to conduct this particular analysis. Referring again to the earlier illustration, observe the manner of which the error of every repeated measure can be derived by taking the total letters and subtracting it with the correct ones (Figure 5.3).

Figure 5.3: Example of Error Propensity

Total Ayat	: 5
Total Letters	: 100
Correct Recitation from Memory	
Measure 1	: 95
Measure 2	: 93
Measure 3	: 98
Average	: 95.3333
<b>Average Error</b>	<b>: 100 – 95.3333</b>
	<b>: 4.6667</b>
Error Propensity	: 4.6667 / 100
	: 0.0467
	: 0.0467 possibilities to make an error

The error propensity in the example was 0.0467. This meant that the participant had a tendency of making 0.0467 mistake when it came to memorizing a part of the Quran within 3 minutes. It was useful to translate the figure into a percentage to gain a better understanding of the ramification. 0.0467 was equivalent to 4.67% of error affinity. In other words, there was approximately 5% possibility that the participant would fumble.

The main motive of gathering the memorization time and error propensity was to measure the impact (Henry, 2012; Sarli & Tat, 2011) of the proposed model as compared to the traditional method. Here, the percentage of reduction was calculated by using the formula in Figure 5.4. Positive reduction signified improvement (Rodrigues, 2010) while a negative one denoted regression (Rooyen, Le Grange & Newmark, 2002). On the other hand, if the reduction revolved around zero (Freedman & Petitti, 2001), and then it may not have any significant impact whatsoever.

Figure 5.4: Reduction Measure

R	: Reduction
Pre	: Measure gathered in pretest (current approach)
Post	: Measure gathered in posttest (proposed approach)
$R = (Pre - Post) / Pre$	
$R > 0$ Proposed approach QM3 is better than the current approach	
$R < 0$ Proposed approach QM3 is worse than the current approach	
$R \approx 0$ Proposed approach may not have any significant impact.	

In addition to the aforementioned analysis, ANOVA (Repovs & Barch, 2012; Hassin et al., 2009; Kensinger, Garoff-Eaton & Schacter, 2007) was also performed on the data collected. It was done to assess the significance of the proposed model on the performance of short term memory with specific regard to Quranic memorization. Here, the pre and post results for the measures (memorization time and error propensity) were compared with one another to test the two hypotheses.

$H_1$  : Participants employing QM3 would exhibit significantly reduced memorization time as compared to those utilizing the traditional approach of memorizing the Quran.

$H_{1(0)}$  : memorization time ( $\mu_{pre}$ ) = memorization time ( $\mu_{post}$ )

$H_{1(a)}$  : memorization time ( $\mu_{pre}$ )  $\neq$  memorization time ( $\mu_{post}$ )

$H_2$  : Participants employing QM3 would exhibit a significantly reduced error propensity as compared to those utilizing the traditional approach of memorizing the Quran.

$H_{2(0)}$  : error propensity( $\mu_{pre}$ ) = error propensity( $\mu_{post}$ )

$H_{2(a)}$  : error propensity ( $\mu_{pre}$ )  $\neq$  error propensity ( $\mu_{post}$ )

To be significant, the difference between the pretest and posttest must be large enough such that the null hypothesis can be rejected and the alternative hypothesis was taken instead via F-statistics. Thus, the first hypothesis  $H_1$  was true when  $H_{1(0)}$  was rejected and  $H_{1(a)}$  was accepted. Similarly,  $H_2$  was deemed as true when  $H_{2(0)}$  was rejected and  $H_{2(a)}$  was accepted.

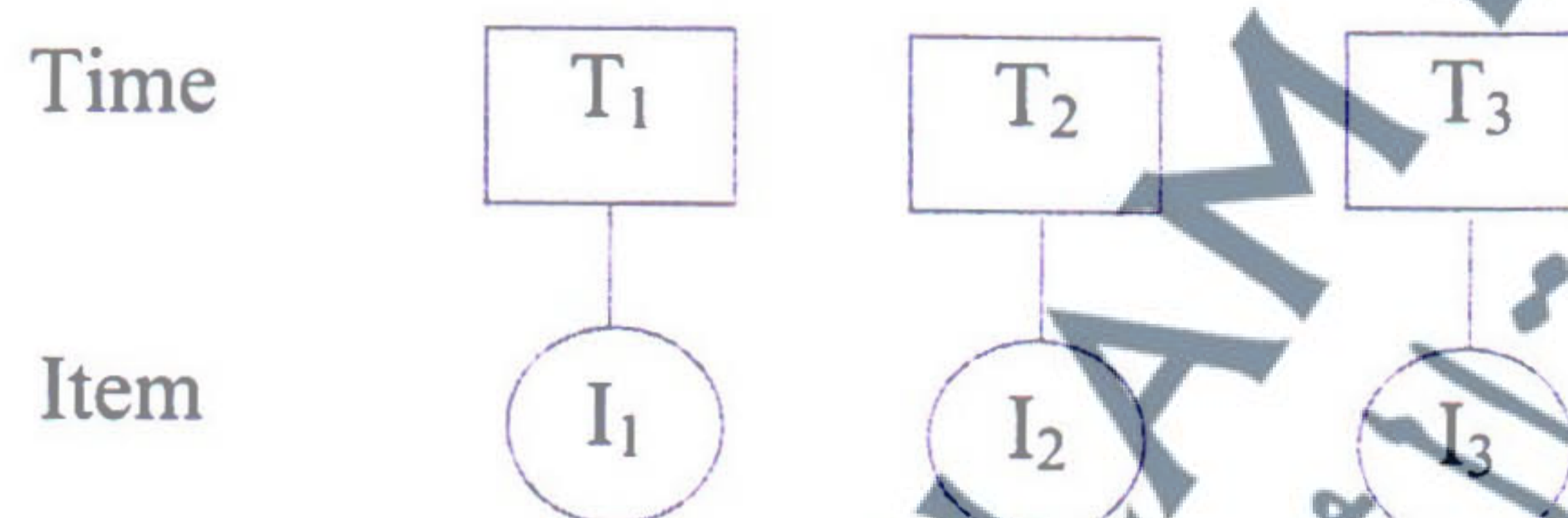
### 5.3 Discussion of the Findings

Quranic Multimedia Memory Model (QM3) was shown to be superior to the traditional method from the aspect of memorization time and error propensity. The improvement offered by QM3 was rather significant. This was validated through the utilization of ANOVA whereby the statistical differences of both approaches were compared based on the two measures mentioned earlier.

In this section, the rationale behind the comparative analysis of the results will be discussed in detail. It began by giving emphasis on encoding (Kitajima & Toyota, 2014; Jonides et al., 2008), which was basically a manner of which a particular information was transformed into a lasting impression in memory. It was rationalized that encoding determined the cumulative efficiency and effectiveness of memorization.

The traditional method capitalized on repetition to enable encoding. Although it can be effective, it lacked efficiency as a whole. To illustrate the time needed for repetition in registering items into memory; consider three information  $I_1$ ,  $I_2$ ,  $I_3$  as in (Figure 5.0). Assume further that it took time to memorize each of these items. The duration to do so was  $T_1$ ,  $T_2$  and  $T_3$  respectively.

Figure 5.5: Memorization of Item that depends on the convention of memorizing the quran and Time



In order to implement repetition, it was not necessary for these items to be connected semantically (Kuhl & Anderson, 2011). Thus, more often than not, they were treated separately. No deliberate effort was made to link a particular item to another. The items  $T_1$ ,  $T_2$  and  $T_3$  were isolated with one another (Figure 5.6) and the inherent connection that existed among them was merely sequential memory. That is, the former was memorized before the latter etc. Isolated memory items did not help each other in memorization. In other words, memorizing the current item will not assist the act of remembering the subsequent ones. This implied that the time  $T_1$  spent on storing  $I_1$  would not reduce the time  $T_2$  that was needed to remember  $I_2$ . For the sake of simplicity, it can be reasoned that the total time  $T$  would be additive by nature, such that  $T = T_1 + T_2 + T_3$  (Figure 5.7).

Figure 5.7: Impact of isolated memory item on memorization time

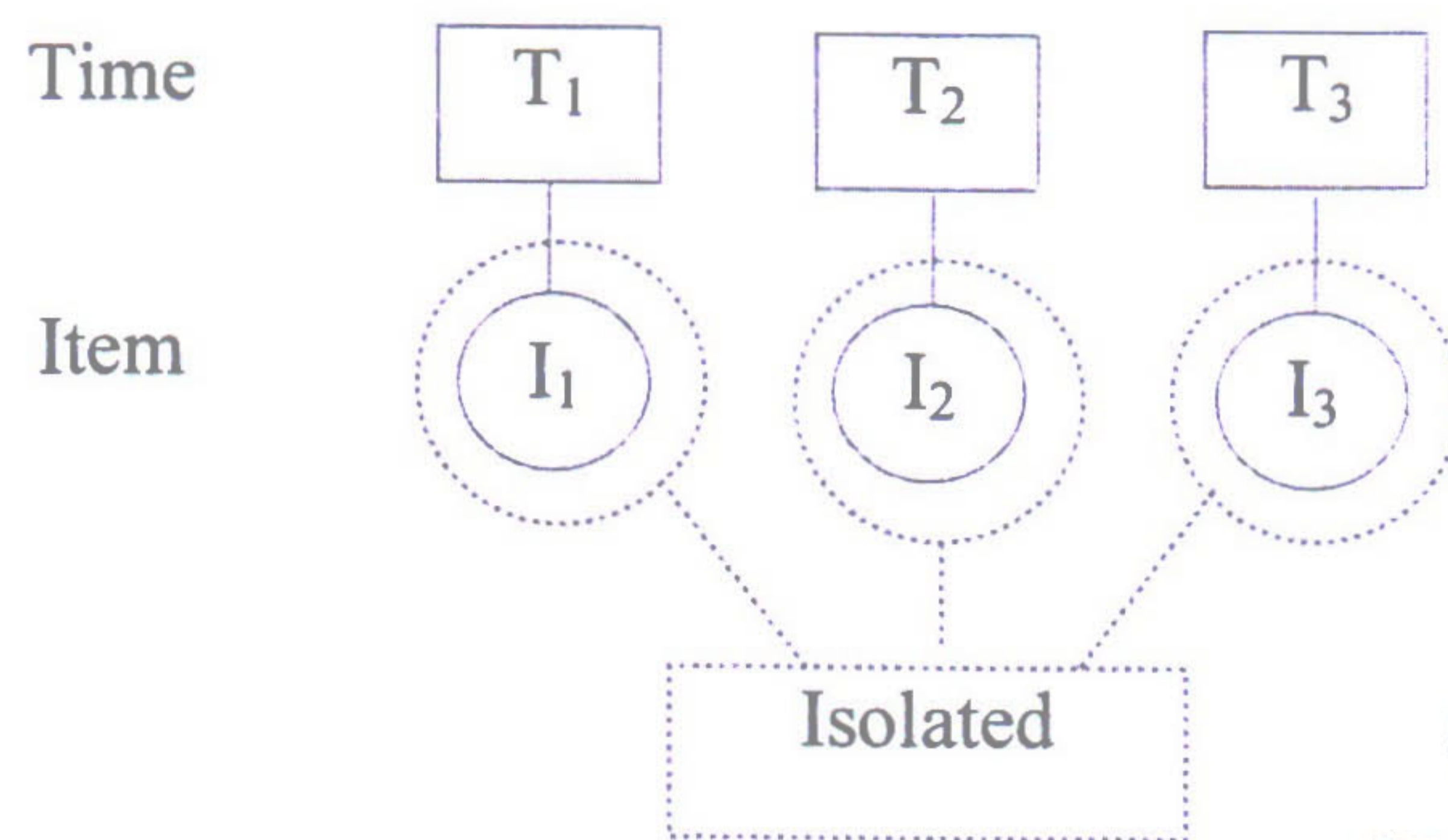
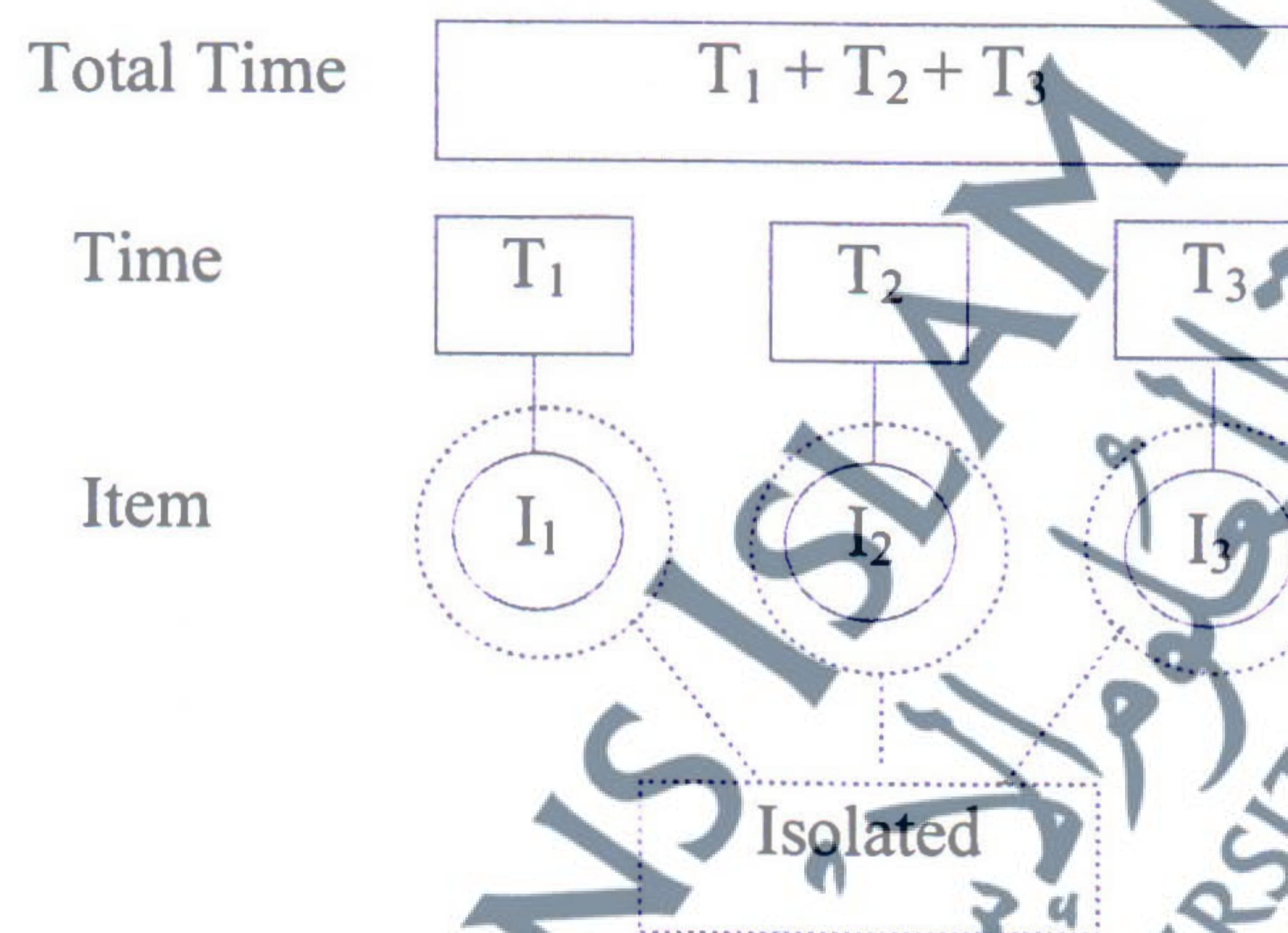


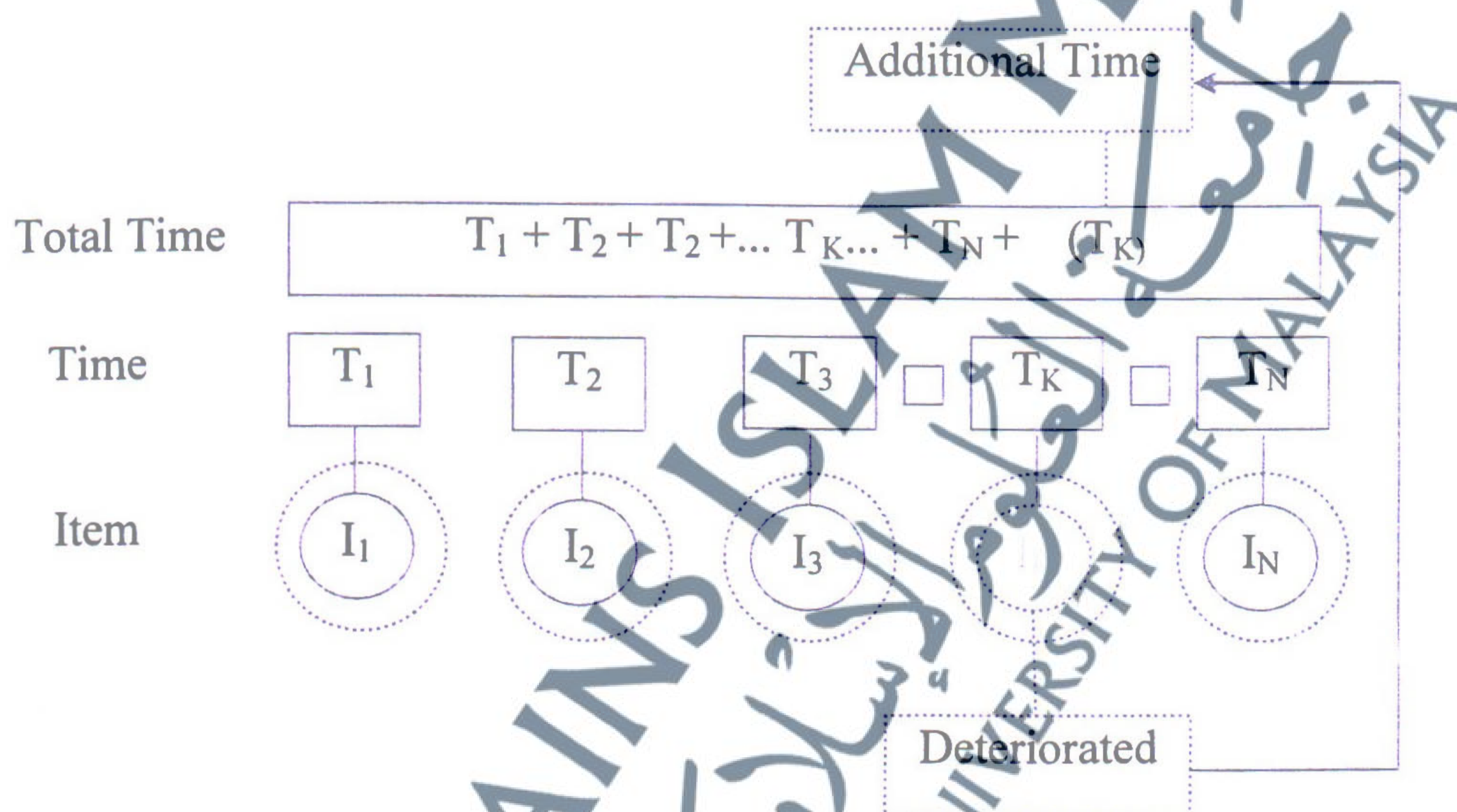
Figure 5.6: Isolated memory item



Repetition suffered other weaknesses as well. A well-known setback of employing repetition in memorizing was fragility. Items committed to verbatim memory via repetition tended to deteriorate or forgotten rapidly through time, a phenomenon known as the forgetting curve (Averell & Heathcote, 2011). Therefore, if an item dissipated from memory, then an additional time was required to refresh it in memory. The time to reinstate a forgotten item depended on the extent of the forgetting endured. If the item was not forgotten completely from memory, then it was hypothesized that the time to refresh it ( $T_R$ ) was less than the time needed to remember it initially ( $T_K$ ) such that  $T_R < T_K$ . However, if traces of the memory was gone altogether, then relearning was demanded whereby  $T_R = T_K$ . Now, consider a set of

items  $I_1 \dots I_N$  to be stored into memory with  $T_1 \dots T_N$  memorization time (Figure 5.8). The total time to remember these items was  $T = T_1 + \dots + T_N$ . Supposed that item  $T_K$  was forgotten during the memorization process. Then an additional time  $T + (T_K)$  was needed. As the number of items to be memorized increased, more items were forgotten, thus, greatly inflating the memorization time.

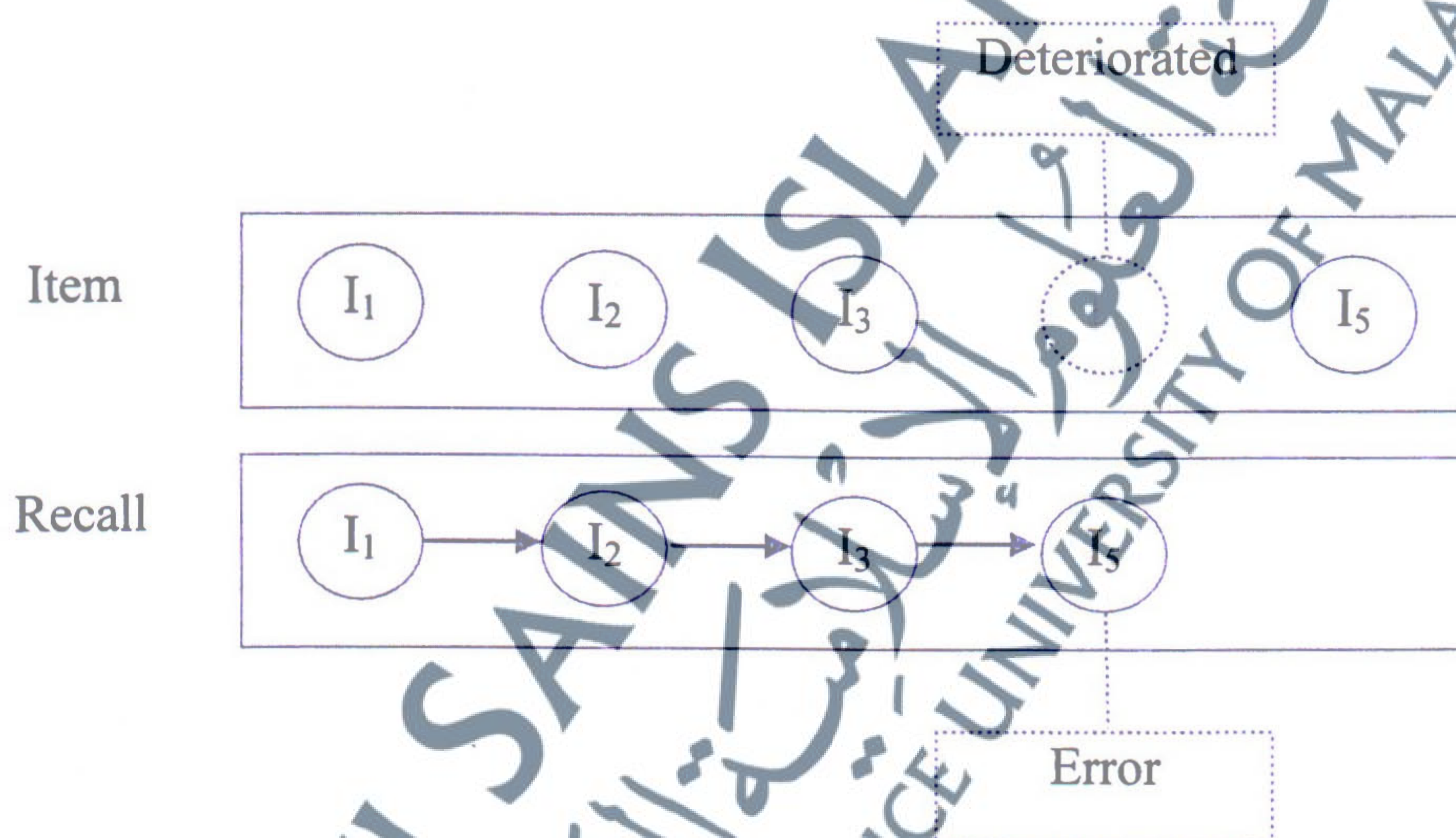
Figure 5.8: Deteriorated item and additional memorization time



Apart from instigating longer memorization time, deterioration or forgetting can also cause a higher propensity of error. Ideas that were nearly or completely forgotten will deter the process of successful retrieval during the recitation of the Quran. As such, there was a greater frequency of mistake. This was quite evident in the experimentation result of error propensity covered in the previous section. Here, error transpired approximately five times more in the traditional method as compared to QM3. Deviation was more prone when repetition was the sole strategy of memorization.

In the illustration (Figure 5.9), five items  $I_1 \dots I_5$  were initially memorized. Along the way, the fourth item  $I_4$  suffered deterioration of memory. This caused  $I_4$  to be omitted during the act of recall and recitation, thus, compelling a mistake of which only items  $I_1, I_2, I_3$  and  $I_5$  were successfully recalled. A more severe predicament may arise from this. Items forgotten can create a chain reaction that disrupted the integrity of memorization. This was especially true for things that were memorized in sequence such as the verses from the Quran.

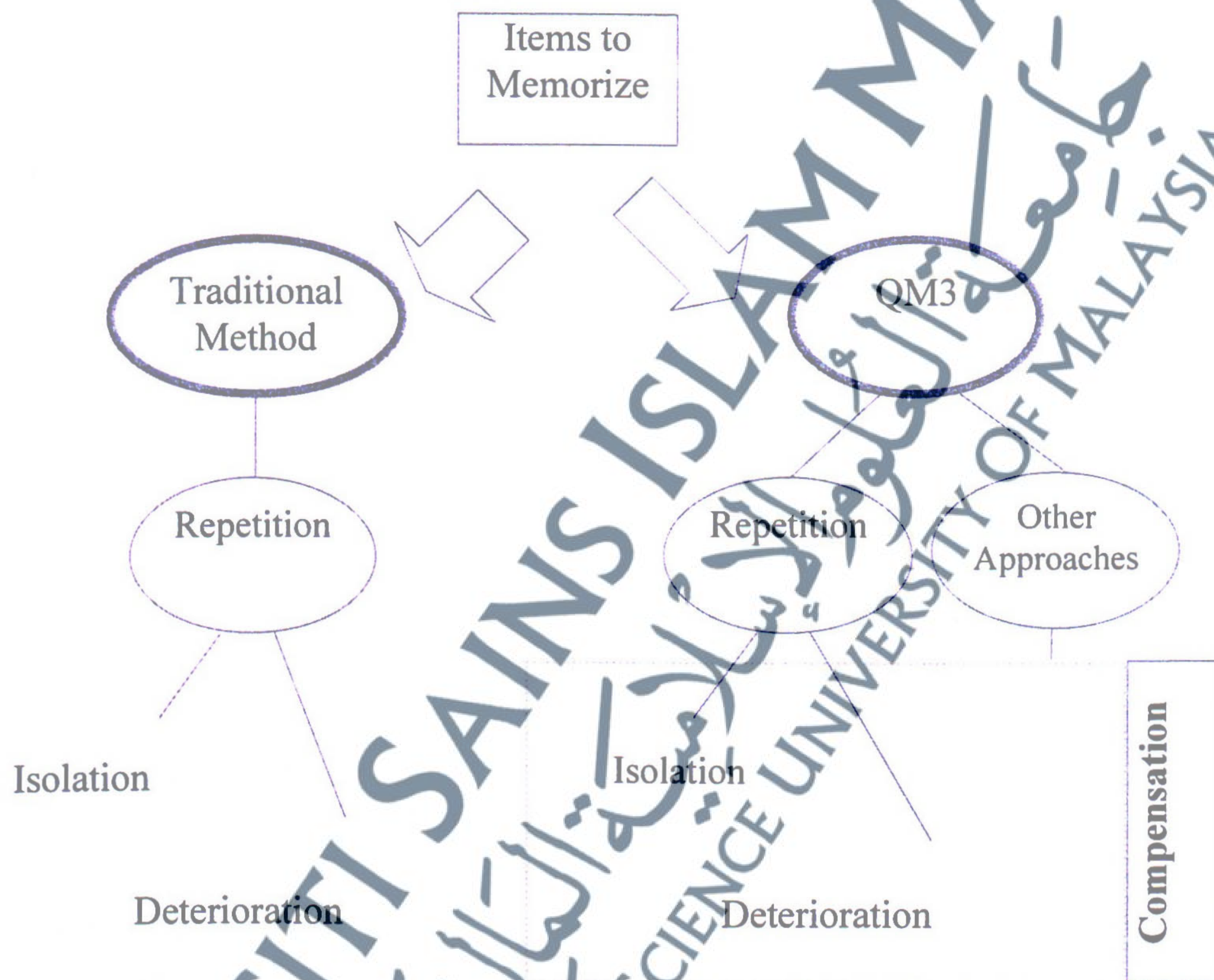
Figure 5.9: Deterioration and error propensity



The traditional method relied heavily on repetition. Students were expected to repeat items a considerable number of trials before being able to remember them. Given the aforementioned dilemma that plagued repetition, it was therefore understandable that the technique would cause the memorization process to be time consuming. Isolation and deterioration extended the temporal requirement of the task.

Compared to the traditional method (Figure 5.10), QM3 did not depend entirely on repetition to succeed. It employed a collection of other approaches such as decomposition, cues and schematization to optimize the memorization process. Therefore, the limitation of repetition was compensated by these other methods. The detailing of this notion will be elaborated further.

Figure 5.10: Repetition in the Traditional method and QM3



To begin, decomposition was the most apparent contributor to a quicker memorization time for QM3. The principle was simple enough. A smaller item was easier to memorize than a bigger one (Jalbert et al., 2011). Decomposition broke down an item into smaller units such that repetition can be applied at a higher rate. It was congruent to the basic strategy of divide and conquers that proposed the need to reduce the size of a task in order to guarantee completion or mastery.

Supposed that the item  $I_1$  (Figure 5.11) can be broken down into three smaller units  $I_{(1,1)}$ ,  $I_{(1,2)}$  and  $I_{(1,3)}$ . If the time to memorize  $I_1$  was  $T_1$ , then it was rather intuitive to assume that the time for each sub-item was  $T_1$  divided by three or  $T_1/3 = T_{(1,1)} = T_{(1,2)} = T_{(1,3)}$ . However, this may not be the case. It was possible that  $T_{(1,N)} < T_1/3$ . This realization was gained by reasoning with the length of the object to be memorized. With the sub-item being shorter than the actual item, the repetition can be performed faster and thus reducing the time (Gupta & Tisdale, 2009).

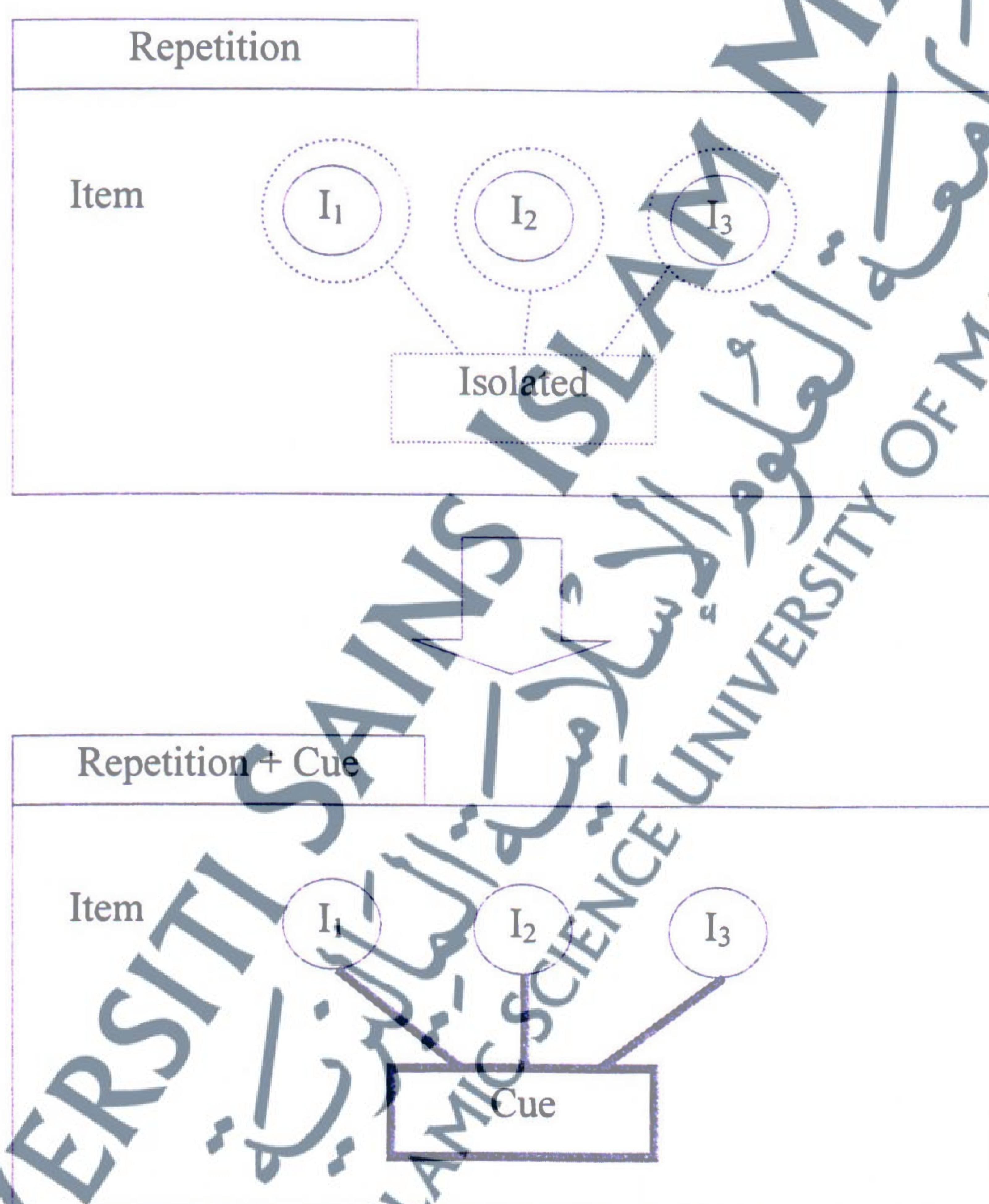
Figure 5.11: Impact of Decomposition on memorization time



The capacity of QM3 to reduce the memorization time can also be attributed to the effectiveness of cues (Kush, Lidz & Phillips, 2015) in consolidating the process of encoding. Unlike repetition that did not offer any linkages between the items, cue improved this process by providing a central relationship between them. This link

acted as an anchor that guided the storage and retrieval of items within memory. In the following example (Figure 5.12), the three items  $I_1$ ,  $I_2$  and  $I_3$  were rather isolated when they were memorized entirely based on repetition. However, by introducing the cue element, the items were now associated with one another. Establishing a relationship via a cue was crucial in memorization because it promoted a better recall as a whole.

Figure 5.12: Repetition and Cue of quran memorization

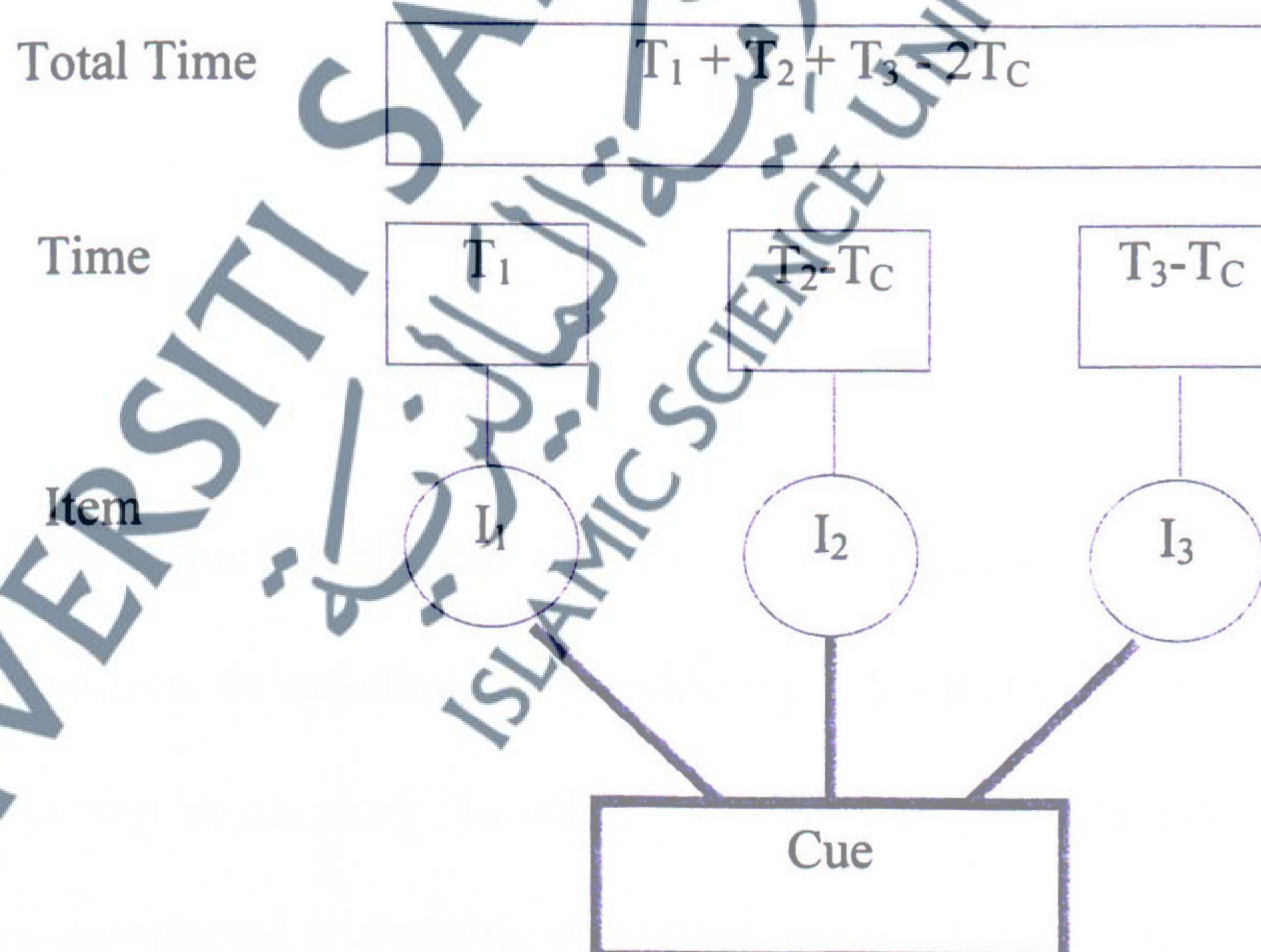


Having a cue enabled the memorization of items to transpire at a faster rate (Liesefeld, Hoffmann & Wentura, 2015). This came from the fact that the memorization of new items was no longer happening in isolation, as what was the norm in repetition. Instead, it exploited the presence of a cue in the process of storing something into

memory. A new item can now be memorized by attaching itself to the cue, which was speedier than without. Recall was faster as well because the cue will direct the act of retrieval in a better way. Searching for the intended item in memory can be governed by the cue as a cynosure.

To demonstrate the potential of using a cue to increase the efficiency of memorization, consider the hypothetical scenario (Figure 5.13). Assume that  $T_C$  was the time saved by attaching a new item to the cue instead of memorizing it in isolation. Thus, the time to memorize a particular item was reduced by  $T_C$  such that  $T_X = T_X - T_C$ . The total memorization time for the scenario below would be  $T = T_1 + (T_2 - T_C) + (T_3 - T_C)$ , or in other words  $T = T_1 + T_2 + T_3 - 2T_C$ . In fact, greater time saving was realized with the increase of items. If there were  $N$  items, then  $T = T_1 + \dots + T_N - (N-1) T_C$ .

Figure 5.13: Impact of Cue on memorization time

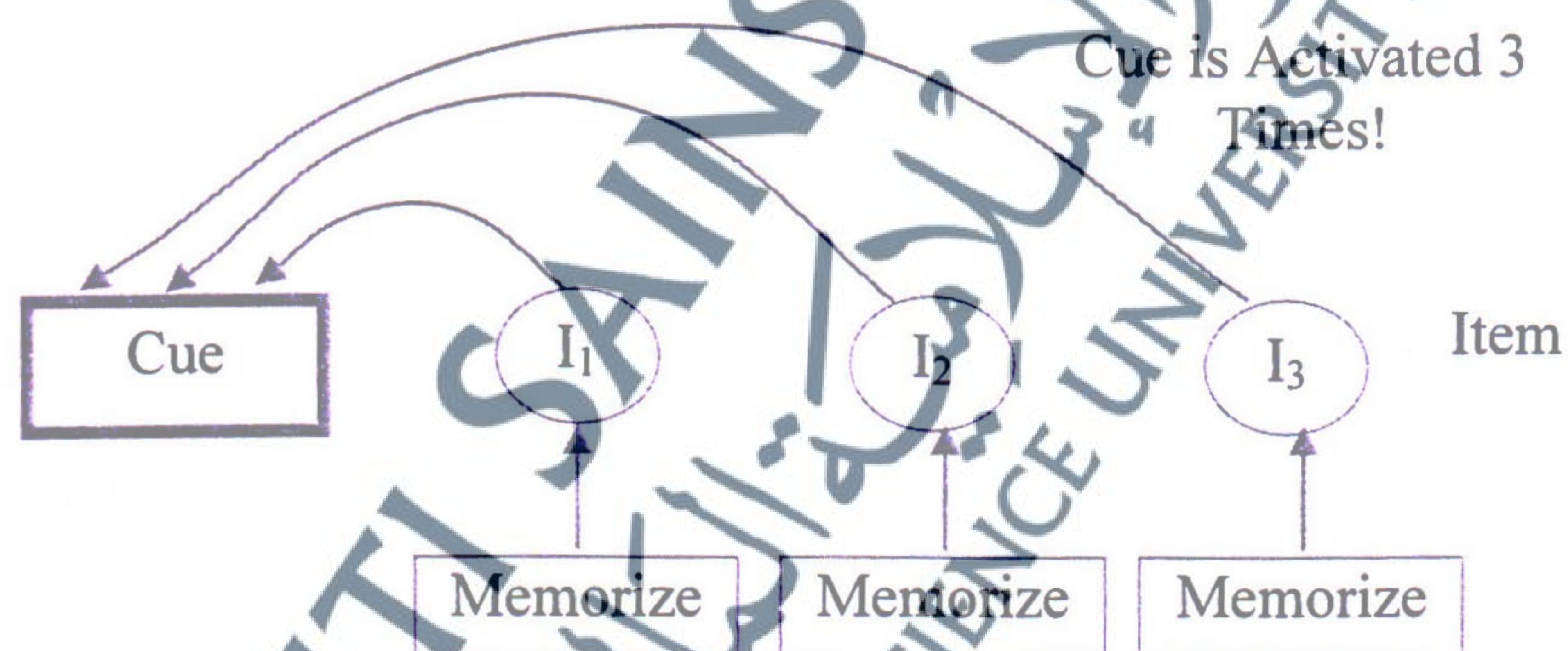


The cue was also the most stable entity among all the items. Stability was achieved

due to its frequent activation with every item memorized (Anton-Mendez & Gollan, 2010). Thus, if there were  $N$  items to be committed to memory, and each of them was connected to the cue, then the cue was referred upon  $N$  number of times. This ensured the integrity of the cue within the long term memory.

In Figure 5.14 the task was to memorize three items  $I = I_1, I_2, I_3$ . During the memorization of the first item  $I_1$ , the cue was activated. This repertoire was repeated for the next two items  $I_2$  and  $I_3$ . During the whole process, the cue would have been activated at least three times. This regular activation of the cue as compared to the other items would make it the most stable one.

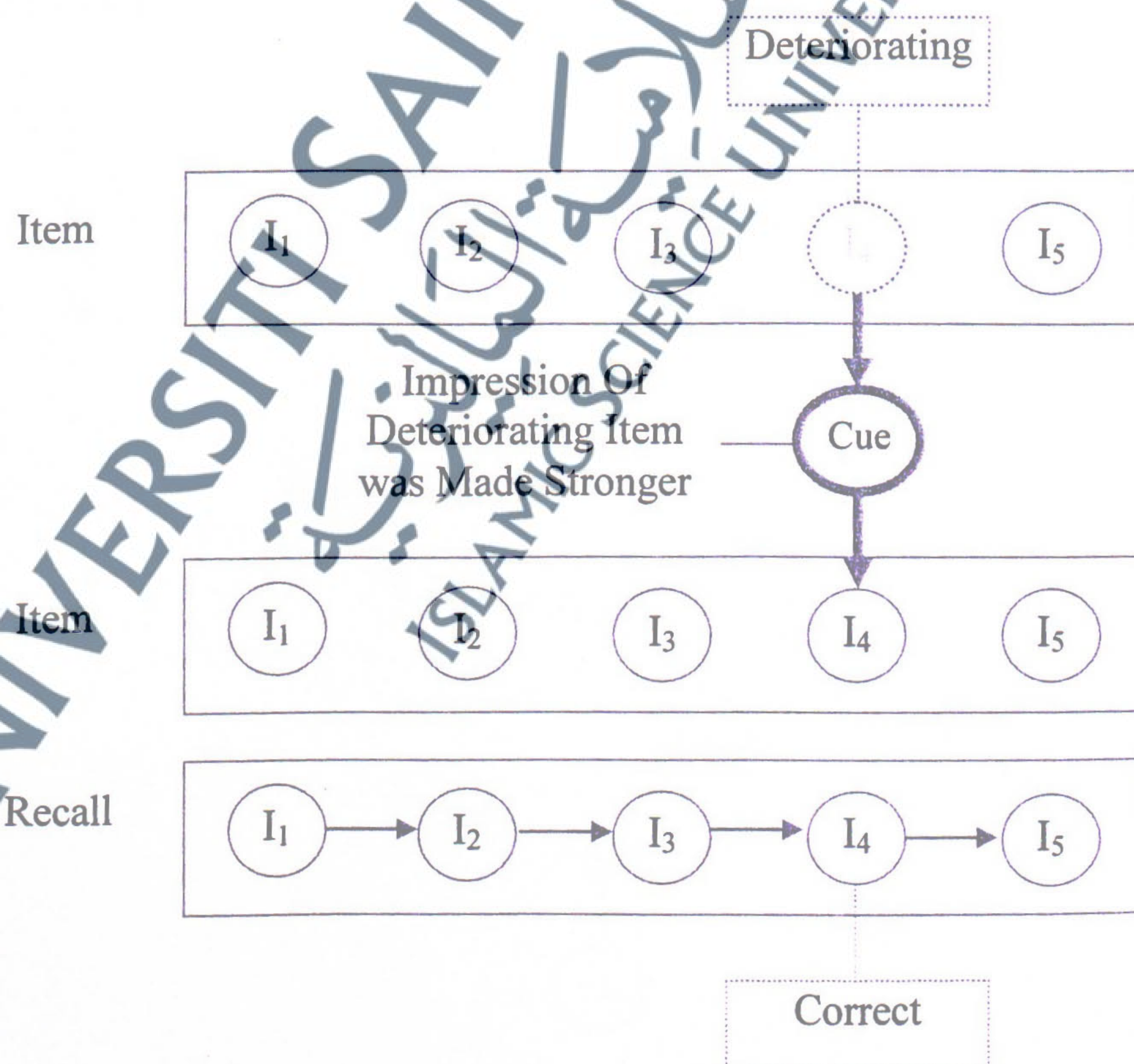
Figure 5.14: Regularity of Cue Activation



Having a stable item such as the cue was rather beneficial in attenuating the adverse effect of deterioration. Its stability can provide a platform for the other items to attain a more solid footing in memory. In other words, when the memory of a weak idea (other item) was connected to a strong one (cue), the weaker counterparts can be made stronger through association.

Now, consider again the case of erroneous recall mentioned earlier (Figure 5.15) that involved the participation of five items  $I_1$ ...  $I_5$  with the fourth item undergoing deterioration. It was quite vital to understand that the deteriorated item  $I_4$  can cause mistakes in recall, which would eventually make the error propensity more severe in the traditional method. This was supported by the result that displayed the likeliness of the traditional method to induce error at approximately 0.15. Suspend the image in mind but this time; however, include the element of a cue inside the picture. What would happen now? The cue now acted as a bastion to memory (Van Dyke & Lewis, 2003). It strengthened the impression of deteriorating items such that their impression can be made stable again. Observe the reinstatement of clarity for item  $I_4$  with the intervention of the cue. As a consequence, the correct recall can now commence without further impediment.

Figure 5.15: Cue and Deteriorating Item



Schematization (Chambers, 2011; Ajideh, 2003) was implemented in QM3 as well (Figure 5.16). It worked in tandem with cues (Monsell, 2003) to imbue a greater degree of memory fortification for combating the detrimental impact of deterioration. This was critical as the number of items grew larger in magnitude whereby a single cue was no longer sufficient. Instead, multiple cues were required to ensure the stability of all the items within the collection. To exploit schematization, the cues were memorized as a group of its own. This way, the cues were linked to one another. Triggering a cue would spark the activation of another cue, which in turn will rejuvenate the memory imprint of all the items connected to it. The stability of the entire exercise can then be sustained effectively with the cycle.

Figure 5.16: Synergy of Cue and Schematization

