

# A Critical Analysis of How Nelly Works

By Professor Patricia Riddell

The learning opportunities provided by Nelly really work as a result of a number of different aspects of the design - the learning is motivating, activates memory in appropriate ways, provides incentives and feedback for the learning, provokes curiosity and provides rewards that cannot be anticipated. Since each of these aspects contributes to the effectiveness of the learning, we will consider each in turn. We will do this by referring to research that shows how we learn best and will compare this to the way that Nelly works to show why this is an effective tool for learning.

## **Learning and Memory**

One explanation for how Nelly works is that it is extremely effective in working with the way that our brains learn and remember. In order to show why this is the case, we have to consider the evolutionary origins of learning and memory. Learning evolved because species need to be able to adapt to new situations in order to survive. Consider, for instance, what would have been required as animals which had evolved on the warm savannah had to adapt to the conditions created by an ice age. There would be a need for different survival strategies to keep warm and find food. Learning what worked in these situations would have allowed some species to survive while others died out - survival of the fittest. Learning mechanisms are crucial here because it is important to be able to repeat strategies that worked.

Similarly, being able to remember your response to some situations would have had survival value. For instance, learning that when a predator appears in your vicinity, you can either run or fight, and that the last time you saw this particular predator, you ran away and survived, might save you a second time. Thus learning and memory evolved to protect individual members of a species in the future by storing information about important events. And this leads us to a second question - what information is stored?

There are potentially two answers to this question: memory stores information about events that have high emotional significance. Imagine your response to seeing a predator that might eat you. This is likely to have created a strong fear response, and the fear that this provoked brings the event to the attention of your

memory and learning systems in the brain. Thus, information that has high emotional content is coded in memory. But there is another way to indicate that information is important, and that is if it is repeated. Individual members of a species would have learned that each year there were very tasty berries to be had in a particular part of their world, or that water could be found in a particular place. The repetition of these events resulted in these being coded in memory.

Human memory is also activated by information with emotional content and things that repeat, and these are aspects of memory that Nelly has successfully engaged. By asking questions to which we know there is a right (and a wrong) answer, Nelly creates an emotional context for the learning. Many people have a competitive nature that causes them to invest emotional energy in being correct. Thus, by providing an opportunity to test our knowledge, we embed the memories in an emotional context. People who are using Nelly are happy when they get a question correct - especially if they perceive the question as difficult. By contrast, people using Nelly are irritated when they get a question wrong - maybe more so if they feel they knew the right answer all along. Memory is more active when both negative and positive emotions are activated, and so both the positive and negative emotional reactions that Nelly can arouse help to make the knowledge more sticky.

And, the questions that participants get wrong are repeated - activating the second way in which the importance of particular information is highlighted so that it can be remembered. Repetition of information is a key aspect of our learning processes and so contributes to better overall coding of the information to be learnt. Thus, Nelly aids learning both by activating our emotional memory and our repetition memory.

But that is not the only reason that Nelly is a great learning tool. Research has looked in to the best ways to repeat information in order for it to be remembered. In one study, participants were given all of the information to be remembered in one block with repetition within the block (massed learning) or information spaced out in blocks with repetition after each block (spaced learning). They were then tested on their recall of the information after a set length of time. Retention of information was better for those that had been in the spaced learning condition compared to those in the massed learning condition. Thus, repetition which is spaced out in time was shown to be more effective in creating sticky memory than repetition which was provided all at once immediately after the learning. Since the questions which repeat the information to be learned are spaced across days, this provides another reason why Nelly works well.

And that is not all - in another study, researchers compared repetition of information to be learned either by presenting the information again or by testing the information to be learnt. This study showed that retention of information was

better when it was tested than when it was simply represented. By testing the information to be learnt repetitively, Nelly is tapping in to this additional means of creating sticky memories.

When we learn new information there are three stages that are required in order that the new knowledge can be used: the two obvious parts to this are that we need to code the information in memory and we need to be able to retrieve that information when we want to use it. Repetition of information to be remembered increases the efficiency of both of these processes. The third process that is involved in remembering new information, and the one that is less well known, is consolidation. In order for information to move from short term memory (which we use, for instance, for remembering phone numbers until we dial them) to long term memory (which provides more permanent recollection of information), the memory has to be consolidated. This involves reactivating the information in memory. Recent research has demonstrated that the time at which our brain does most consolidation is at night when we are sleeping. Thus, Nelly is best designed to create conditions in which our brain can consolidate by providing information during the day, which is then consolidated overnight, and then reactivated by testing on subsequent days, before further overnight consolidation. By spacing the repetition of information across days, Nelly makes best use of the brain's need to consolidate while we sleep thus increasing the retention of new learning.

In summary, there are a number of aspects of the design of Nelly that make it an effective learning tool. First, it activates both emotional and repetition memory tapping in to the two forms of memory available. Next, it spaces learning across days which has been shown to create better learning than massed learning of the type we typically find in training programmes. The learning is both reactivated through questioning and tested - again enhancing the strength of the memories created. Finally, by spacing the learning across days, Nelly is able to best use the brain's consolidation processes which take place at night when we are asleep.

## **Curiosity**

Another way in which Nelly works is that it taps into the natural curiosity of human beings. One of the aspects of the human brain which has allowed us to survive as a species is our natural ability to create new solutions. This ability is provoked by the human drive for novelty. If things remain the same in all aspects of our lives all of the time, most people become bored and seek new opportunities. While we like the familiar, we are also driven to explore the new. This need to explore is activated in the brain by rewarding curiosity - the reward centres of the brain are activated when we feel curious. Researchers have scanned people's brains while they were being asked trivia questions. What surprised them was that the reward

centres of the brain were active when people were anticipating hearing the answer to the question. Imagine that you were asked to consider a question like:

*What is the largest rodent in the world?*

Or

*Who played Kojak in the hit TV series?*

When you consider the answers to these questions, you are rewarded by an increase in the activity of the dopamine reward centres in the brain - whether you know the answer or not. If you know the answer, you are looking forward to finding out you were right and if you don't know the answer, you are looking forward to being put out of the misery of not knowing or, worse still, not being able to remember what you know you know.

Now imagine what happens in your brain when you are answering questions supplied by Nelly. Every time you open a new question, and begin to consider the answer, there is a little reward as you anticipate confirming your answer or finding out the answer. Whether right or wrong, there is a reward to be had. No wonder people enjoy working with Nelly.

### **Motivation to Learn**

What motivates us to do anything? Research suggests that there are three main aspects of a task that make it intrinsically motivating - we are motivated when we feel that we have chosen to do a task ourselves (autonomy), when we feel capable of doing the task because we have the relevant skills and knowledge (competence) and when we engage socially with others through the task (relatedness). Nelly ticks each of these boxes in our self-motivation processes.

When we do things that we have chosen we find them much more rewarding than when we feel that we have to, or ought to, do a task. Compare how you feel when you tell yourself that you must do something (I must wash my car tonight, do the dishes tonight, learn something new today) versus when you ask yourself if you want to do something (Do I want to wash the car tonight, do the dishes tonight or learn something new today). You should find that you are more willing when you ask yourself if you want to do something than if you tell yourself that you must do it. Even within our own brains, we prefer to be in control.

And autonomy doesn't need to involve choosing the task. A sense of autonomy can be created by giving people a choice of how to, or when to, do something. If you know that your car needs to be cleaned, ask yourself when you would like to do this, or whether you want to do it yourself or by taking the car to a car wash. You

should find that you are more willing to complete the task when there is some choice involved.

Most people that sign up for Nelly enjoy answering the quiz like questions and so would choose to do this anyway. But Nelly also gives them a choice over when they answer questions each day and this choice feeds in to the human need for autonomy. People feel in control of their own learning and so are self-motivated to learn.

And through this learning, people are able to increase their capability to do their job - which is also intrinsically motivating. By providing immediate feedback, Nelly helps the learning process by providing moment to moment information about how well an individual is doing. Individuals find out which bits of their job they know well and also where they need to improve. This provides motivation to go back to a topic that was not well learned. And then Nelly provides the opportunity to determine whether revision of that particular topic has been successful. This constructive feedback creates the opportunity to increase competence and provides feedback on how successful an individual is in their own learning. In this way, the learning that is created through Nelly provides motivation by increasing competence in job performance.

Finally, by creating a means to compare scores with others on the team, Nelly can increase the feeling of camaraderie and build both personal and team engagement. This adds to the motivation to participate by activating relatedness.

Since three of the main ways that people are intrinsically motivated to engage in tasks is through autonomy, competence and relatedness, it is easy to see why people find learning with Nelly an engaging process and thus why little external motivation is required to encourage people to participate.

## **Gamification of Learning**

The final piece in the jigsaw of how Nelly works is our intrinsic enjoyment of games. The gaming industry know that people find it much more rewarding when they cannot anticipate when the next win will come than when rewards arrive at known times. This is one of the draws of gambling - whether the reward comes from betting on horses, card games or fruit machines. The one constant in all of these is that reward is intermittent. When we begin to expect to win - we no longer find it so rewarding.

Educators have begun to catch on to this and more programmes that use games in learning are beginning to appear. Nelly is at the forefront of this movement. By delivering learning through the medium of a quiz that can be downloaded as an app, it appeals to our love of games - and the love of our smartphones. Questions

can be set to be easy or hard and so there is intermittent reward - some questions can be answered quickly and without much thought while others take more time to master. And this intermittent reward drives people to want to do better - thus increasing their learning. It is really pleasing to think that at the point at which Nelly is no longer rewarding because it is too easy, the learning process is more or less complete. It couldn't have a better design!

### **Combining the Processes**

Nelly is a great learning tool, not because it taps into one of the processes that allow people to learn with little effort, but because it combines a number of these processes. Repetition with emotion taps in to the way that our memory has evolved to work by clearly highlighting the information that is important to learn in the moment. Spaced learning increases the repetition, again highlighting the importance of the information to learn. By not only repeating the information, but also testing it at the same time, deeper learning is fostered. And all this happens while reaping the reward of activating our curiosity.

Nelly is self motivating because it taps into the major processes that cause humans to be motivated namely feeling as if we are in control, demonstrating our competence and engaging with others. There is no need to push people into working with Nelly - when they have been introduced to Nelly, their own self-motivation will keep them learning. And the intermittent reward of getting questions right (and some wrong) will keep people learning until the process becomes boring. And at that point, Nelly's work is done since the learning will be complete.



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