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Research paper

Cognitive Development in Active eLearning

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Abstract

There has been an ongoing debate amongst educators about the role of memory versus intelligence in fostering effective learning. It has long been held that learners are more successful in retaining new content if they consciously think about what's being taught, as opposed to simply memorizing what they see on the slides or on a computer screen. The learning theory of cognitive development plays a huge role in the case of the former approach—understanding by thinking. Because of its very nature, where time and distance often separate instructors and learners, the cognitive process plays an even more important role in eLearning.
Nowadays learning style has been changed. A suitable technique for teaching courses needs to be adopted to improve the learning effectiveness of students. Modern technology and an up-to-date tool affect student learning abilities, especially in 21st century learning, which requires students to learn by doing. Active learning and eLearning tools and environment are aspects that can encourage students to have high learning efficiency.

Keywords: *Design Thinking, Seductive Details Effect, Cognitive Load, Active Learning, E-learning, Bloom's Taxonomy.*

1. Introduction

For the most part, our existing education system focuses more on theory than practical approach. That is the reason why people tend to forget rotely learned concepts so easily. On the contrary, Augmented and Visual Reality (AR and VR) make learning a practical experience. And experiences are what stick with online learners and enable them to recall the information for later use. Some concepts that in theory appear to be dry, fail to catch online learners' attention for more than 15 minutes. However, AR and VR can make them more interesting by adding practical application and immersion to eLearning. This also helps online learners to appreciate the importance of concepts and ideas instead of merely brushing them off as a theoretical knowledge that has no correlation with their work duties or responsibilities.
If you are required to be creative on demand in your daily work, you may find that a design thinking model suits your needs. Design thinking is an approach for deeply understanding the audience and their challenges, in order to generate creative and effective solutions.
Although the new technology provides higher levels of learning outcomes, it has not been established that it affects all students. The purpose of this article is to look at interesting results that will affect new research, focusing more on practical work rather than the application of the theory.

2. Cognitive Process More Important Role in eLearning

2.1. Focus on a practical approach rather than just theory.

The eLearning industry is all about making use of advanced technologies to enhance the learning experience. In the end, the basic aim is to make learning an easy and enjoyable task. Achieving that target without incorporating the latest technological tools is virtually impossible, especially since we are fully immersed in the digital era. Thus, augmented and visual reality have slowly but surely been edging into the eLearning sector for some time now. These additions have been warmly accepted by modern learners because of the many benefits they offer. Here are 5 benefits to put into perspective:

1. Make the eLearning process engaging and exciting.
2. Create scenarios that otherwise are impossible to create.
3. Focus on a practical approach rather than just theory.
4. Encourage online learners to learn from their mistakes.
5. Allow for self-guided exploration.

Here are some design guidelines drawn from the literature.

1. The addition of graphics to learning materials typically improves positive feelings about learning. Use relevant and instructive graphics to improve learning and avoid irrelevant graphics, as they hinder learning [1].
2. Ensure that learning experiences activate relevant prior knowledge at the start so that learners build accurate knowledge structures. If you add motivational content that may be irrelevant, delay its introduction until learners have processed the essential material or not at all [2].
3. Avoid background music in eLearning as this appears to overload auditory working memory, interfering with retention and learning transfer [3].
4. You can promote understanding by adding relevant and interesting adjuncts to a learning experience. These include summaries, explanative illustrations, and similar strategies [4; 5].

5. Consider the subject matter. In one experiment, seductive details impeded learning in a lesson on earthquakes but improved understanding in a lesson on history, where images and photographs resulted in more time spent on the reading task [6]. Is it possible that seductive details in science, engineering and technical topics are more harmful than in less technical topics?

In order to make courses engaging, particularly compliance-type courses, you may add content that is tangentially related to the topic in the hopes of motivating or entertaining the audience. These additional elements are known as seductive details.

A seductive detail is an element added to instructional materials that is highly interesting to the audience members, but not directly relevant to the instructional goal. The seductive detail can be in the form of a text passage, a photograph, cartoon, illustration or even a video or parts of a video. A seductive detail might be background music. Much research has verified that the seductive detail effect can "reduce the recall and/or comprehension of learning information" [6]. The principle states that people learn more deeply from multimedia when these interesting but irrelevant details are excluded [2]. In one meta-analysis of studies, [5] found that seductive details negatively affect both retention (small to medium effect) and learning transfer (medium effect).

2.2. How do seductive details interfere with learning?

Evidence points to a few possible reasons that seductive details reduce retention and learning transfer in many learning situations. Two key reasons are cognitive overload and schema interference.

High Cognitive Load: A primary explanation is that seductive details overload working memory Due to the fact that working memory is limited in capacity and duration, processing extraneous material may reduce a learner's ability to process the essential material [3]. The inclusion of entertaining but irrelevant material may decrease a learner's ability to synthesize the new information needed for skill acquisition and learning [7].

Interference with Building Schemas: Another explanation is that additional details interfere with building appropriate schemas or that they disrupt the formation of a coherent mental model [4]. Schemas are theoretical knowledge structures for mentally organizing information.

Seductive details might confuse learners as to what a lesson is about and activate irrelevant prior knowledge. The result would be that the learner has an incorrect framework for organizing knowledge. In one experiment, researchers added many seductive details *at the start* of a reading passage. This appeared to interfere greatly with recall and problem solving [2] more than when the details were introduced later.

Do seductive details ever improve learning?

With all of the negative effects that seductive details have on learning, are there some conditions in which they improve learning? In some cases, it appears that seductive details can foster learning because high-interest content can increase intrinsic motivation. This can energize learners to persevere and spend more time learning.

One study suggests that individuals who have high prior knowledge may benefit from the addition of tangential content. The hypothesis is that these learners are operating during a low cognitive load condition, so that seductive details added interest and benefited learning [8]. And another showed that seductive details increased attentional focus for trainees with high prior knowledge while reducing attentional focus in trainees with low prior knowledge [9].

2.3. Realistic graphics and learning.

Realistic graphics, are often not as effective as those with reduced realism.

Low-fidelity Graphics and Learning

Low-fidelity graphics can be more effective for learning when you need to:

- Provide an explanation to people with limited knowledge of the content
- Focus only on essential details
- Ensure viewers recognize an object quickly
- Strengthen the impact of a message

For example, you might choose low-fidelity graphics in a beginners cooking course that is explaining the use of various utensils. In contrast, high-fidelity photographs would work best when teaching more experienced chefs about presentation of the final meal.

2.4. Cognitive load

Working memory (WM), the part of our brain that consciously processes information, dominates everything we do in terms of learning. Working memory can only hold 4-5 bits of information at one time and information in working memory lasts only around ten seconds.

The fact that our working memories have a small capacity and a short duration is worthy of headline news. It's what we're up against as humans and as learning experience designers.

Interactions Between WM and LTM

Unlike working memory, long-term memory appears to have an unlimited capacity. Information in long-term memory (LTM) is stored in schemas, which are mental structures we use to organize and structure knowledge. Schemas incorporate multiple elements of information into a single element with a specific function.

The interaction goes both ways. We construct new schemas in working memory so they can be integrated into existing knowledge in long-term memory. And existing knowledge in LTM is brought into working memory to help us understand the world. Otherwise, everything would be new all the time!

Many times, we can achieve the most effective visual communication by abstracting and simplifying a graphic. We will need to balance the goal of reducing realism enough to improve cognitive processing, while at the same time, leave enough detail so that viewers will comprehend the graphic as it was intended.

When thinking about digital learning, our cognitive architecture looks like this (see figure 1):

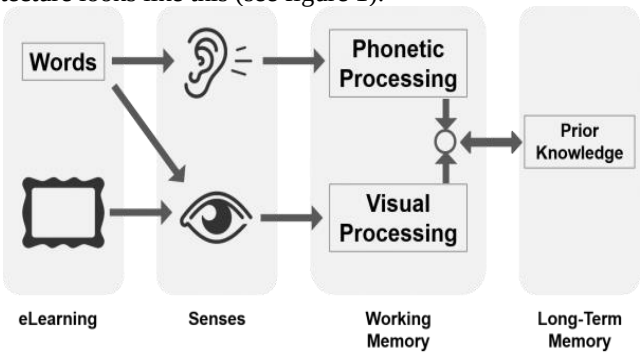

Fig. 1: Digital learning cognitive architecture.

So, let's look at some things you can do to manage cognitive load in digital learning and help the learning process. Often, it's about reducing extraneous cognitive load.

1. **Use the visual and auditory channels** as this helps to spread the cognitive load. However,

presenting audio and identical on-screen text results in redundant information being processed by the learner. Audio should be used to describe what's happening on screen to be most effective. Exceptions to this are people are not native speakers of the language and for accessibility.

2. When using text and images, **text should be placed near the corresponding parts of the image**. This will reduce split attention.
3. **Avoid using decorative images**. The image/diagram used should be directly related to the material being presented and not be there to 'jazz up the screen'.
4. **Less is more:**
   • Focus on essential information, write concisely.
   • Eliminate extraneous visuals, text and audio – get rid of 'nice to know' information.
   • Eliminate redundancy such as unnecessary words and modes.

We can reduce working memory load by providing external memory supports, more commonly known as performance aids or performance supports. Performance aids are beneficial when the time is limited to build schemas into long-term memory. They can be used before and after more formal training methods but aren't suitable if something needs to be completed quickly and accurately. Performance aids are most effective when they predominately use visuals.

All of the research into our memory systems and the cognitive load is extremely useful as it provides evidence-based insights into how people process information. In turn, it allows designers to create activities based on the processing limitations that people have. As a result, by incorporating these factors into our designs, we can improve the overall learning experience.

3. How to Incorporate Active Learning?

Active learning is an educational approach in which educators enable students to construct their understanding, teaching them to become problem solvers and critical thinkers. In contrast to a classic 'chalk and talk' presentation in which an instructor delivers information to students, students learn how to gather, analyze, and evaluate information themselves.

Incorporating active learning into the classroom requires changing the environment from one of passive information reception to one of inquiry and desire to understand. This shift in thought can be achieved by adopting several related practices and attitudes.

Fig. 2: Bloom's Taxonomy pyramid.

Learners need to become familiar with Bloom's Taxonomy (see figure 2) and show it to their students. Instructor and student efforts should focus on moving students up the pyramid to higher-order knowledge.

In 1956, Benjamin Bloom, an educational psychologist, developed a classification of levels of cognitive skills important in learning [10]. In the 1990s, a group of cognitive psychologists, led by Lorin Anderson, updated the taxonomy, changing the original noun-based classification to verbs. The diagram presents the revised framework.

To better understand it, figure 1 the learning journey as a staircase. At the top of this staircase you have mastered the topic but to get there, you need to go through a few stages. On the first step, you'll simply have knowledge of the topic. As you progress, you'll become more familiar with it and the knowledge will turn into behavioural change.

Where does Bloom's Taxonomy come in? If you're an instructional designer, a teacher or a lecturer, it's up to you to help your learners move through every step. Bloom's Taxonomy is a list of verbs that you should be using for learning objectives in each step. (see figure 3).

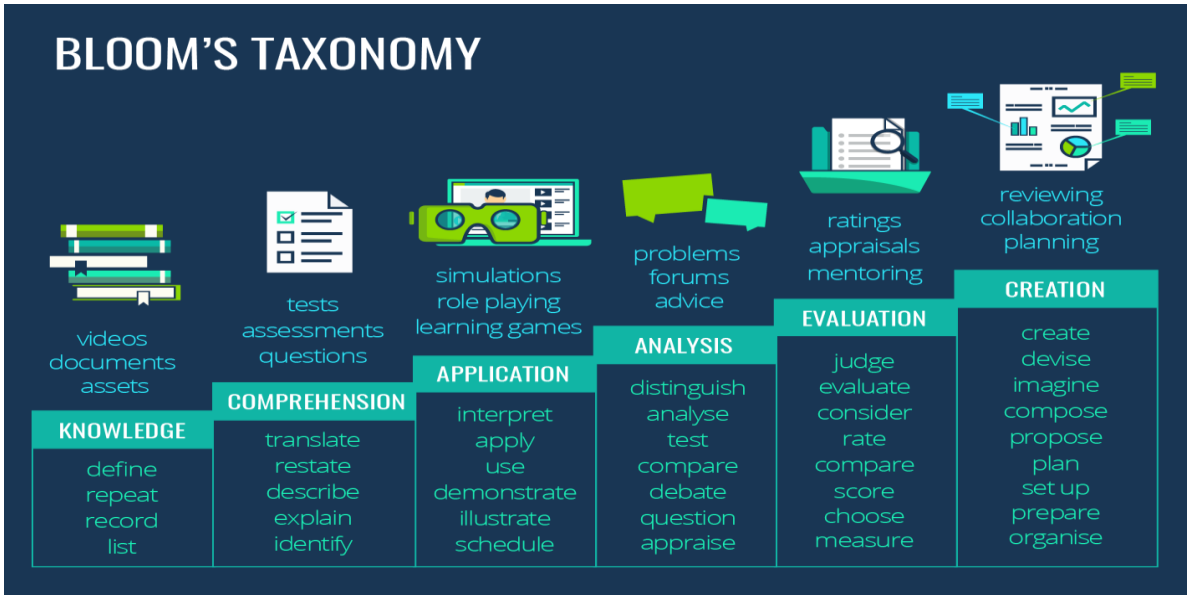

Fig.3. Bloom's Taxonomy steps.

In the lower half of Figure 3 above, there are certain tasks that are appropriate for your learners depending on where they are:

Knowledge

The lower levels on the learner's journey represent basic knowledge. At this stage, the learners should be able to remember things that they have learned previously. If you want to make sure they've mastered this step, you'd ask them to define a concept, repeat something they've already heard or list the steps in a process.

Knowledge in online learning

In an online learning context, you can use different assets to deliver the knowledge that your learners need. We'll take a tutorial video as an example. If you wanted to use Bloom's Taxonomy as a guide, you would follow this video with a question that asks them to repeat something from the content.

At this stage, you're only checking that they've been paying attention and they've absorbed the knowledge – checking their understanding comes in the next step.

Comprehension

Knowing something is not the same as understanding it. For the learning to have any real impact, it's pointless to simply learn a sentence by rote. At this step in the journey, you'll want to check if your learners can translate the knowledge into their own terms.

Comprehension in online learning

You can check comprehension in several ways in an online learning context. Learning management systems usually come equipped with flexible testing tools. It's down to the learning manager to ask the right questions to take the learner beyond the stage of simple knowledge recall.

Application

Once the learner understands the concept, they need to be able to apply what they've learned in a practical context. If you want to help your learners past this level, you'd ask them to 'use what you have learned…' or 'demonstrate an occasion when you applied this knowledge'.

Application in Online Learning

Applying the learning is a powerful indicator that you're delivering the message effectively. Depending on your industry, you could create exercises on your LMS or host simulations online. For example, McDonalds used an online simulation of their tills to train their employees.

This type of simulation is known as a 'serious game'. Game-based learning is a growing field that's getting impressive results. The main reason for its success is that it targets learners further up the chain of Bloom's Taxonomy, and doesn't rely merely on knowledge recall.

Analysis

Analysing a concept is the next step on the journey to truly mastering it. It goes a step beyond simply applying the knowledge and it demonstrates a deeper understanding. Typically, a trainer would present the learner with a problem or an issue without giving too many clues as to the solution. This extra challenge makes the learning more engaging and leads to better results.

Analysis in Online Learning

Testing functionality and questions can be used on the LMS as before, but there are other ways to spark an analytical approach. If your LMS has social functionalities, you can unlock opportunities for informal learning.

Things like discussion forums and expert areas encourage learners to ask each other for advice and offer their own insight. In this way, the learners take ownership of their professional development. This gives the training much more meaning and, ultimately, a greater impact.

Evaluation

You can think of evaluation as a more confident form of analysis. At this stage, the learner has gained enough expertise to make recommendations based on their analysis. It's perfectly reasonable to give these learners responsibilities within the training programme. They can start acting as tutors to those learners who are still in the earlier stages of their journey.

Evaluation in Online Learning

In the realm of training and development, reaching the evaluation stage does more than simply train the students. It can become the catalyst for real cultural change within the student group. Such a powerful thing needs to have the right technology in place to maintain the momentum.

In this case, the learning management system takes on a whole new purpose. It becomes a social network for everyone in the study process and it secures student engagement from induction through to the higher levels of professional development.

Creation

Bloom's Taxonomy creation stage is the final point outlined by Bloom's Taxonomy. Here, the learning manager is placing a greater responsibility on the learner. They might ask the learner to create a plan for a process within the business or etc.. The learner needs to have followed all of the other steps if they are going to feel confident enough to complete an objective at the creation stage.

Creation in Online Learning

Few training initiatives are robust enough to even reach this stage and fewer still can tackle it online. Coordination at this level takes a huge amount of collaboration and it's essential to gather all the knowledge from every student or student group.

In an ever-changing world, the online platform also needs to allow the users to review and evaluate all the assets it contains. With these capabilities in place, learners who are creating a new process can use all this information, fully confident that it's accurate and up to date. This process also ensures that anything they end up creating is perfectly tailored for the student and education esatblishment organization needs.
An example of the framework as applied in Business course in Riga Technical University:

- Can the student remember/recite the definition of opportunity cost?
- Can the student understand/restate/explain the definition of opportunity cost?
- Can the student apply the concept of opportunity cost in a given context?
- Can the student use the concept of opportunity cost to analyze/compare/contrast situations?
- Can the student suggest and justify using the concept of opportunity cost to analyze a novel economic situation?
- Can the student evaluate/critique an analysis based on opportunity cost?
- Can the student create a new use of the concept? Can she create a related concept?

4. Conclusion

The rate of information dissemination has dramatically increased, due to technological development and global interconnection. An educational system that focuses on memorization and lower order cognitive skills is obsolete and inefficient. Instead, curricula can be reorganized to emphasize problem-solving and other higher order skills. Through inquiry-based teaching practices, educators create an environment of inquiry, helping students to seek more than simple answers, to explore the mechanisms underlying what is known, and to learn how to create knowledge themselves.
Bloom's Taxonomy is a concept you'll come across pretty quickly once you start exploring the world of learning. Although you'll normally see it in the context of teaching children, Bloom's Taxonomy applies to learning at all levels. If you're teaching adults in a training and development environment, it can be an incredibly powerful tool to help change behaviour and get better results from the training programme.
The role of the teacher as the facilitator in setting goals, providing guidelines and resources, and providing suggestions and support to the student is a key factor in successful e-Learning-assisted instruction.

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