Surface and Deep Learning

**Surface learning** is the more factual information or surface knowledge that is often a prerequisite for deep learning.**Deep learning** involves things like extending ideas, detecting patterns, applying knowledge and skills in new contexts or in creative ways, and being critical of arguments and evidence.” (Merrilyn Goos). Later in the term you will see how Bloom’s Taxonomy outlines this progress from surface to deep learning along a continuum of higher **order thinking skills**.

As you read about surface and deep learning, consider the implications of how teachers plan lessons for diverse learners. Do these students have opportunities to engage in deep learning or are they stuck at the memorization and facts level of the curriculum? If a student cannot memorize multiplication facts, does that mean he/she cannot advance in mathematics?

***Deep learning*** first requires recall and use of ***surface*** knowledge and skills (Webb, 2005). ‘Traditional’ approaches like memorization and rehearsal can equip students with these foundations (Hattie, 2012), but the problem is that teaching and learning often stops at the surface.

Robyn Gillies from University of Queensland: Research shows that student-centered approaches to teaching that change and develop students’ thinking gets better student learning outcomes than the more traditional, teacher-directed, information-transmission approaches. For teachers to make this shift, it’s important to have the capacity to reflect on one’s own practice and to be familiar with evidence-based research into effective teaching.

To be effective, learning must be active. Effective and active learning are interdependent and one cannot occur without the other. They are two sides of the same coin. When learning is effective, students are actively engaged and they are motivated. They accept responsibility for their learning, work together to achieve shared goals, listen to others’ ideas, and support one another through challenges. The effectiveness of active learning is not limited to the academic or cognitive, but extends to social and personal development.

What is surface and deep learning? Expert perspectives

[Click here to watch video lecture](https://youtu.be/vLUFCxl5Zb4) (Video 4:27 minutes)

A range of experts in different fields describe their understanding of**surface and deep learning**. {Video transcript]

PANKAJ SAH: From a neuroscience perspective, the learning that takes place in the classroom is essentially about memory formation – it’s storage and its retrieval. An understanding of brain functions will help us understand how that memory formation retrieval system operates.

Now in terms of an understanding of surface and deep learning, neuroscience tells us that the brain is a plastic organ which changes during learning, and there are changes to both the structure and function of the brain. These changes are different depending on whether the learning is surface or deep. There are many different views in neuroscience about what is surface learning and what is deep learning.

One way of distinguishing them is to think of surface learning as immediate or short-term learning, and deep learning as a consolidation process that leads to long term changes. In terms of the biology of taking learning from surface to deep, we think what is happening in the brain during consolidation is protein synthesis and development of new connections.

In surface learning, while proteins are modified, they change and decay over a short period of time. It is in the consolidation process that this surface or immediate learning becomes long-term or deep learning through changes in gene transcription and new protein synthesis. In animal models, we’ve found that if you block the protein synthesis the long term or deep learning is blocked, but not the short term or surface learning.

Professor DAVID REUTENS, Director of the Center for Advanced Imaging: The world we live in contains a lot of information, a lot of facts, and we encounter new information all the time. My understanding of deep learning is that it’s a process of integrating new facts about the world into our existing semantic framework.

It’s not like storing and retrieving information from a computer. Deep learning is not about memorizing things, but integrating the facts that we have into aggregates of information and models about how the world works. I know that my memory isn’t great, but I can know plenty of things by integrating and connecting information.

MERRILYN GOOS: From an educator’s perspective, surface learning involves recalling and reproducing content and skills. Deep learning involves things like extending ideas, detecting patterns, applying knowledge and skills in new contexts or in creative ways, and being critical of arguments and evidence. One way we can understand how students are making meaning from what they are learning is to see how they engage in problem solving – either by themselves or with others.

PIETER ROSSOUW (From Mediros Clinical Solutions): Is there a difference between so-called deep learning and surface learning? Are there benefits in each of these? The research shows that there are big benefits in surface learning. However, surface learning is a linear process, which is also quite often a very small neural process.

Deep learning means we add neural connections so that we can see the consequences, the benefits, applied in different environments, et cetera. That’s more of an extensive neural network, rather than a simple neural network.

Surface learning’s quite often the first line of learning, but from there we need to extend this into more extensive neural networks. That’s what we refer to as deep learning in comparison to surface learning.

Features and differences between surface and deep learning

In this next video, Professor John Hattie, from the University of Melbourne, who is a leading educational researcher in the field of surface and deep learning, adds his contribution to the variety of practitioner and disciplinary perspectives on deep learning provided in the earlier videos.

Drawing on nearly two decades of research involving more than 240 million students, John has written extensively about the factors that make the most difference for learners. John argues that students need both surface and deep learning, and identifies a number of strategies that are most effective in both phases. However, these strategies can be more or less effective, depending on phase of the learning cycle in which they are used.

In this video, John describes the features of and differences between surface and deep learning, and outlines when the various strategies associated with each are, and are not, appropriate.

[Click here to watch video lecture](https://youtu.be/6FS7NQpegMM) (7:28 minutes)

Slightly Abbreviated Transcript.

John Hattie: It’s a very important distinction between**surface and deep learning.**

* **Surface learning** is very much about the idea, the content, the knowledge and the information.
* The **deep learning**is when you relate or extend or transfer that knowledge.

Certainly, in many schools in many systems there is both those two parts – the content and how we relate and extend that content is critical. But the differences between surface and deep learning are important. On the one hand, I don’t want to imply that it’s a straight, very sharp distinction between the two of them.

On the other hand, you can see them as a graduation from having an idea, from having many ideas, and that’s the surface part and then relating those ideas, and then extending the ideas. Certainly, to have relationships between ideas, you have to have ideas and this is partly why we can see them as a bit of a continuum. Now the issue is that, as you start relating and extending ideas, they start to form a new idea. And then you’re back to the surface part of the cycle again. It’s a continuing cycle. But, certainly the argument is that in any form of learning, any form of teaching, it’s really important to know where the student is at. The aim is to have plus one, go to the next level as much as you can.

**Q. When are Surface and Deep learning strategies appropriate or inappropriate?**

As you’re starting to learn something for the first time, the appropriateness of surface learning comes to the fore. Like if you’ve never played golf, you’ve never driven a car, you’ve never played canasta, then I would expect in the first few lessons that 90% plus of the lesson would probably be about surface learning. In fact, driving a car’s a good example, whereas as a parent, we teach our kid about defensive driving and getting a sense of where they are in the car and making sure that they have anticipation. And at that moment, all they care about is where the brake is. They want to know the surface level.

Great teaching knows what to focus on. But after a while, surely, it’s important to move.

The proportion of surface from 90% say, and start to relate ideas to make it to the deep side of the things– side of the equation. Here’s the problem– when we do observations of classrooms, when we do analysis of student work and we ask the question, what skills typically does a student need to do work in our schools? 90% plus, all they need a surface level knowledge. Surely, that’s not right.

And that’s what I didn’t say. I didn’t say what the teachers think because teachers always think it’s deep learning. In fact, one of the big mistakes we make is we go to deep learning sometimes far too quickly. So it’s a really important distinction to make as to find out where the student is in that cycle of surface to deep. Then there is part of the deep learning you want them to transfer to similar and to different tasks.

**Q. When should learning shift from Surface to Deep**?

When should learning shift from surface to deep? I’m struggling to find any article ever written that addresses that problem. And I think that’s a major issue for us. Now I don’t want to imply that there was actually a moment when suddenly you should go from surface to deep. It’s a continuum. In fact, learning is very much a staccato. But certainly, we should be aware as instructors about where the students are on that complexity of learning cycle from surface to deep. And certainly, at some point we should be saying to the students, stop learning more and start relating them.

See, my answer to this particular question is to look at the work you ask the student to do, look at the assessment, look at the particular task, and say, which part of it is surface, and which is deep? In fact, in all my own work I usually have at least two questions for every concept. A surface question and a deep question. So, it’s very clear to the student what I’m asking for, and it’s very clear to me.

Students are very smart. They don’t do what you ask them to do. They don’t do what you tell them to do. They do what they think, you think, is valuable. And what is valuable is using your assessments.

So, if you work backwards and construct your assignments, construct your tasks, and have a surface part and a deep part. Make it plain to the student that’s what it is. We need to know that you know the content. We need to know how you’re going to relate the content. Then marking and scoring is a lot easier because you can have a surface and a deep compartment. And that’s certainly what we see as the big distinction.

**Q. How can learners be supported to ‘transfer’ their understanding to new contexts?**

Despite 150 years of study, it’s very hard to find evidence of how you teach transfer. But we would certainly argue from the work we’ve been doing in the Science of Learning Center, it is possible. And here’s a very simple example. Let’s say I teach you something, and then I want you to apply it to a new situation. Like you learn something in history about Australian history, and I want you to apply it now to American history. Or I give you a math problem and I want you to try another math problem. Before you do the next problem, if you stop and ask the question, what are the similarities and differences between these two contexts, then transfer can happen. The problem is, many students learn something, then go to the next problem, start solving it using the same strategy and it doesn’t work.

I do think there’s a lot we can learn about near and far transfer that that’s very important.

**Q.What learning strategies work best when students are engaged in Surface Learning as opposed to Deep Learning?**

In this learning cycle of moving from surface to deep, there is another kind of moderator, and that is, when you first are exposed to something, I’m going to introduce you to distillation, or I could introduce you to a new period of Queensland history. Then when you’re first expose the strategies that work, are quite different from the strategies at the next part when I ask you to consolidate. Remember, we humans have little brains. Most of us can only remember five, plus or minus two things at any one time. In many senses we have to **over learn** a lot of the surface knowledge. This is why, in mathematics, for example, once you get the notion that 9 lots of 6 are 54, memorize it, and over learn it so you’re not sitting there saying, when, someone asks you to do a problem, well what’s 9 times 6. Those students who learn how to over learn can then move to the next phase.

When we did the work with Nola Purdie many years ago, looking at Asian students in Australia, particularly at university level, they spent a lot of time over learning the surface level knowledge so they could then spend their time doing the relating and extending. There was a lot to be asked about the strategies that matter at the different stages of surface and deep. And I think it’s really important that we include **transfer** in the equation.

Reflection

Professor Hattie suggests that around 90% of classroom teaching and learning focuses on surface knowledge and learning. Do you think this is true of your own classroom? How could you find out?

What strategies could teachers use to determine which phase of the surface-to-deep learning cycle a student is in?

Reference:

UQx: LEARNx Deep Learning through Transformative Pedagogy (2017). University of Queensland, Australia. (An Open edX MOOC). Module 1: Surface and Deep Learning