**Willingham’s 10 Principles of Learning**

Each chapter of Willingham’s book deals with one cognitive principle. Below I’ve listed the table that appears at the end of his book summarizing his 10 Principles of Learning, but I’ve added to the table the title of each chapter and some salient quotes and ideas from that chapter.

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| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **1** | People are naturally curious, but they are not naturally good thinkers | What is just beyond what my students know and can do? | Think of to-be learned material as answers, and take the time necessary to explain to students the questions. |
| **Chapter title: Why Don’t Students Like School?**  “Despite the fact that we’re not good at it, we actually like to think. We are naturally curious, and we look for opportunities to engage in certain types of thought. But because thinking is so hard, the conditions have to be right for this curiosity to thrive, or we quit thinking rather readily” p.7  “So, if content is not enough to keep your attention, when does curiosity have staying power? The answer seems to like in our judgement of how much we are likely to learn. Curiosity is maintained when we think we’ll learn a lot.” P.10  “Working on problems that are of the right level of difficulty is rewarding, but working on problems that are too easy or too difficult is unpleasant.” P.11  “For problems to be solved, the thinker needs adequate information from the environment, room in working memory, and the required facts and procedures in long-term memory.” P. 17.  **Teaching Application:**  Ensure that there are problems to be solved in your classroom. Ask fantastic questions that make students think, because, “...it’s the question that piques peoples interest. Being told an answer doesn’t do anything for you” p.19. Respect students cognitive limits. Think about working memory and know what overloads it and how you can help it.  The brain loves novelty and a change of pace to help with attention, so once in a while use something new to pique interest. For example, I had a teacher once who put a lit candle on everyone’s desk before we entered the class (this was Grade 7 science class). He knew we were mature enough not to set the place on fire! We were captivated! What’s this? Bravo Mr. McQuaid!!  Keep a diary of your teaching, your students and things that have worked and have not worked.  Allow your students to know why you are doing what you are doing: “Okay, I’m asking a series of questions here to make you think. I want you to work for the solution because a working brain is a learning brain, and having to apply effort strengthens neural pathways.”  Finally, think about your students’ Zone of Proximal Development and challenge them just at the upper edge of their current level of ability. Students prefer work that has the right mix of challenge and likelihood for success. | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **2** | Factual knowledge precedes skill | What do my students know? | It is not possible to think well on a topic in the absence of factual knowledge about the topic |
| **Chapter title: How Can I Teach Students the Skills They Need When Standardized Tests Require Only Facts?**  “Thinking skills depend on factual knowledge” p.25  Someone may say, ‘well, I can just Google it’...No! Just looking up information is not enough and is not a substitute for have factual knowledge. You need factual knowledge to think... to reason, to be creative and to think. Every students must accumulate a good foundation of factual knowledge in order to think. “Critical thinking processes are tied to background knowledge” p.29  “We must ensure that students acquire background knowledge in parallel with practicing critical thinking skills” p. 29.  “Data from the last 40 years leas to a conclusion that is not scientifically challengeable: thinking well requires knowing facts, and that’s true not simply because you need something to think about. The very processes that teachers care about most – critical thinking processes such as reasoning and problem solving – are intimately intertwined with factual knowledge that is storied in long-term memory (not just found in the environment).” P.28  “knowledge is essential to reading comprehension” p.30 “A number of studies have shown that people understand what they read much better if they already have some background knowledge about the subject” p.35  “...we don’t take in new information in a vacuum. We interpret new things we read in light of other information we already have on the topic” p.36.  Most of the heavy lifting in thinking is actually done in long term memory. It’s what we have stored in memory that helps us think. The difference between my wife and I when it comes to looking in the cupboard? I see food and she sees recipes. Her background knowledge on the topic of food allows her to think creatively. I need a recipe.  “Factual knowledge improves your memory” p.43 Those who have more, gain more!!! “...the people with background knowledge remember substantially more of the material than people who do not have background knowledge” p.43 This occurs because new material has familiar prior knowledge to link to and hold on to...”we remember much better if something has meaning.”  **Teaching Application:**  When you require critical or creative thinking, ensure your students have enough relevant background knowledge to work with in order to succeed. That being said, “Shallow knowledge is better than no knowledge” so don’t refrain from trying something just because your students don’t have enough background knowledge...just understand that limits to background knowledge may limit what to expect.  Promote a lot of reading....and acquiring as much knowledge in the subject area as possible. Sometimes more is caught than taught, so don’t downplay the importance of incidental knowledge.  Finally, knowledge should be meaningful. That does NOT mean students like it or find it applicable to them....but they should see it as important and worthwhile to learn. | | | |
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| **3** | Memory is the residue of thought | What will students think during this lesson? | The best barometer of every lesson plan is “of what will it make the students think?” |
| **Chapter title: Why Do Students Remember Everything That’s on Television and Forget Everything I Say?**  Memory is mysterious and certainly we likely forget more than we actually remember. But how can I get students to remember the things I want them to remember. The key here: you need to get students to think about what they need to remember. Memory is the residue of thought...so think carefully what your lesson gets students to think about....because that is what they will remember. Get them to dwell on it.  “things can’t get into long term memory unless they have first been in working memory” p.59. Working memory is that aspect of your consciousness where you process thought...it’s where you manipulate and use information. We must put the information we want students to think about first in their working memory. This occurs through environment (teaching, exposure to information) and retrieval from long term memory.  “Things that create an emotional reaction will be better remembered, but emotion is not necessary for learning” p.63.  Repetition is not enough, but it’s important. Intention is not enough, but it’s important. What really makes a difference is meaning! “we’re poised to say that thinking about meaning is good for memory” p.65  “The emotional bond between students and teacher –for better or worse—accounts for whether students learn” p.70  **Teaching Application:**  “...a teacher’s goal should almost always be to get students to think about meaning” p.66 It is NOT a matter of relevance to the student...a great many things in life are important and worth knowing that are not necessarily relevant to one’s life....so don’t spend your time trying to make subject matter relevant to each student....the material has meaning on it’s own and we need to get students to see meaning.  The Power of Stories: Willingham devotes several pages to the power of the story to help students remember material. “The human mind seems exquisitely tuned to understand and remember stories”.... easy to remember, easy to comprehend and they are interesting. Use stories to highlight your lesson, give necessary background information, or to examine the material using a story line involving the 4 C’s to organize your lesson: causation, conflict, complications and character....and yes, you can teach math using these types of story lines.  Review your lesson plans and ask yourself: what am I getting students to think about? Students remember what you make them think about. Caution: sometimes students remember your attention grabbers and enthusiasm but forget the content.  Get students to think about the questions that underly the lesson. Think about using mnemonics to help students remember information. Don’t be afraid of letting your students struggle with the question and solutions...this is good for their memory. | | | |
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| **4** | We understand new things in the context of things we already know | What do students already know that will be a toehold on understanding this new material? | Always make deep knowledge your goal, spoken and unspoken, but recognize that shallow knowledge will come first |
| **Chapter title: Why Is It So Hard for Students to Understand Abstract Ideas?**  “The surest way to help students understand an abstraction is to expose them to many different version of the abstraction –that is, to have them solve area calculation problems about tabletops, soccer fields, envelopes, doors and so on.” P.97  “Understanding is disguised remembering” p.97. They understand new ideas by relating them to old ideas and things they already know. This is why prior knowledge is so important. And this is why analogies are so crucial to teaching...they bring the unfamiliar into contact with the familiar.  Some may think that the best way to make abstract ideas understandable is to make them concrete. But if you do not understand the concrete example it won’t help you much. What’s more important is to make the abstract idea linked to something that’s familiar. “...it’s familiarity that’s important” p.99. “The problems are solved, not by giving new information, but by arranging what we have always known” p.99.  You already know all this....no one can pour new ideas into a student’s head directly...they must be built upon prior knowledge to have meaning.  Be wary of promises of broad transfer...the brain does not work that way. For example, you cannot improve executive function skills by playing chess. You cannot improve problem solving skills by playing Wordle or crosswords every day. Instead, you may get better at chess or Wordle or crosswords, but those activities do not transfer into those other cognitive domains.    **Teaching Application:**  Provide plenty of examples for students to compare and contrast to. Provide non-examples too and explain why they are non-examples.  From page 114: “You very likely let your students know that you expect them to learn what things mean –that is, to learn the deep structure. You should also ask yourself whether you send unspoken messages that match that emphasis. What kind of questions do you pose in class? Some teachers pose mostly factual questions, often in a rapid-fire manner: ‘what does b stand for in the formula?’ or ‘what happens when Huck and Jim get back on the raft?’ The low-level facts are important, as I’ve discussed, but if that’s all you ask about, it sends a message to students that that’s all there is.”  “Students draw a strong implicit message from the content of tests; if it’s on a test, it’s important” p.114, so be careful what messages you send in your assignments and tests.  Be realistic about your expectations for deep knowledge. “Deep knowledge is hard won and it’s the product of much practice” p.114. | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **5** | Proficiency requires practice | How can I get students to practice without boredom? | Think carefully about which material students need at their fingertips, and practice it over time |
| **Chapter title: Is Drilling Worth it?**  “It’s virtually impossible to become proficient at a mental task without extended practice” p.119.  “To understand why practice is so important to students’ progress, let me remind you of two facts about how thinking works...working memory is the site of thinking. Thinking occurs when you combine information in new ways. That information might be drawn from the environment or from your long-term memory or from both...A critical feature of working memory, however, is that it has limited space. If you try to juggle too many facts or to compare them in too many ways, you lose track of what you’re doing...This lack of space in working memory is a fundamental bottleneck of human cognition...though you can’t increase working memory capacity, you can cheat this limitation.” P.122   1. “...the first way to cheat the limited size of your working memory is through factual knowledge”....as you have more foundational knowledge to draw upon, you have more to utilize. The best chess players have thousands of moves and scenarios memorized and in their long term memory from which to draw upon...the same goes with mechanics, surgeons, artists and athletes. 2. Automation. Think of the automation of tying your shoes or driving the car...you don’t have to think about it anymore and your cognitive resources are freed up now to do other things. Automation comes from practice. Period. “Mental processes can become automatized. Automatic processes require very little working memory capacity” p.123.   Simply put: the more you study something the longer you remember it. People who have taken several university courses in calculus, for example, have shown that they have forgotten very little of their math knowledge compared to those who took only one or two math courses. The more you know and the more you practice what you know, the more you retain.  **Teaching Application:**  Repetition of ideas is crucial...of course, and ‘overlearning’, though it may sound boring or over-the-top is necessary. Reteaching, dropping reminders, ample practice in various formats and review of what you want students to think upon, is important.  However, not everything can be practiced extensively, there simply isn’t enough time to allow for this. So, think about which processes need to become automatic. Number facts? Letter sounds? Vocabulary/meaning? Science facts about formula, laws, etc?  Ask yourself what needs to be automatic in order to free up cognitive space in working memory....insist that these become automatic.  Space out the practice of concepts over time...there’s really no need to insist a ‘once and done’ approach to curriculum. Teachers need to revisit important concepts all year long even though a unit may be long since completed. Ensuring that there’s lots of variety in practice is important.  Finally, think of teaching skills concurrently. You can work on several skills and knowledge at various levels of understanding and proficiency all at once (e.g. learning letter sounds while also learning about elements of a good story). | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **6** | Cognition is fundamentally different early and late in training | What is the difference between my students and an expert? | Strive for deep understanding in your students, not the creation of new knowledge |
| **Chapter title: What’s the Secret to Getting Students to Think Like Real Scientists, Mathematicians, and Historians?**  Okay, this is going to sound negative, and likely not what you want to read, but there is a significant difference between novices and experts, and the very skill we’re hoping to see in our students is not likely going to be there...because they are novices and they simply are not yet capable of thinking like or behaving like experts.  “Real scientists are experts. They have worked at science for 40 hours (likely many more) each week for years. It turns out that those years of practice make a qualitative, not quantitative, difference in the way they think compared to how a well-informed amateur thinks” p.145.  “...but it takes more than knowledge to be an expert.”... experts actually process and use new knowledge much differently than novices do...and that’s because their storehouse of knowledge (examples, non-examples, trials and errors, successes, etc. etc.) add substantially more to the intake of new information. Truly, the rich get richer! When you put a large snowball and a small snowball at the top of a hill and roll them down the hill at the same time, the big snowball increases in size at a much greater rate than the small snowball does....more surface area picks up more snow. The same sort of thing happens with accumulated knowledge and skill. Further to this, information is organized differently and experts see relationships to information differently now...often in terms of function and use. “Experts don’t think in terms of surface features, as novices do; they think in terms of functions, or deep structure.” P.149. “Experts do not just narrate what they are doing. They also generate hypotheses and so test their own understanding and think through implications of possible solutions in progress” p.153  **Teaching Application:**  “The only path to expertise, as far as anyone knows, is practice” p.154. Okay, you knew that already, what else? How can you help students move past the novice stage of learning? Teach about mind set and hard work. Yes, that’s right. “The great minds of science were not distinguished as being exceptionally brilliant, as measured by standard IQ tests; they were very smart, to be sure, but not the standouts that their stature in their fields might suggest. What was singular was their capacity for sustained work” p. 155.  We need to talk about this with our students. It’s not creativity or inspiration or some mystic intelligence latent within the student waiting to come forth serendipitously someday. Nope, it’s hard work and the belief that progress happens over time and with lots of corrective practice.  Experts also create. This is unique to experts...they “not only understand their field, they also add new knowledge to it” by creating new knowledge. Our students are not yet at that stage.  Okay, so we may not be dealing with experts in our classrooms, but we still seek and teach habits of mind that we want to see in them...and we ask them to try to create and think and experiment and try new ideas. Encourage students by reminding them that ‘practice makes progress’...and with sustained hard work they will get better and better at what they do. Also, it’s a good idea to teach students to work collaboratively, ask lots of questions and seek the help of others. This is what experts do. If you really want to get good at something you need to become a student of that skill. I’ve noticed in recent years that gamers often follow other gamers in social media and watch them to learn how to solve problems within their own gaming...skateboarders do this too....as does anyone who wants to get better at their craft or skill. | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **7** | Children are more alike than different in terms of learning | Knowledge of students’ learning styles is not necessary | Think of lesson content, not student difference, driving decisions about how to teach. |
| **Chapter title: How Should I Adjust My Teaching for Different Types of Learners?**  It’s so important to re-emphasize the cognitive principle here: Children are more alike than different in terms of learning.  “...teachers should be aware that, as far as scientists have been able to determine, there are not categorically different types of learners” p168.  We mustn’t be confused on cognitive abilities and cognitive styles: abilities have to do with how we deal with content and reflect the level (that is, the quantity) of what we know and can do; styles are how we prefer to think and learn. Many of us link our personalities and preferred approaches to life (e.g., laidback vs. go-getter) with how we define ourselves as learners...our style and preference to learning. That’s fine. But here’s the key point to remember, even though your bias to learning may be toward one method over another, it is not true that in order for you to learn, material or teaching must be delivered in that format. There are literally hundreds of studies confirming that preferred learning styles do not cause learning to occur better for some children than for other children. Teachers must keep in mind that learning preferences of their students have no impact on whether or not they will learn in your class.  **Teaching Application:**  “I would advise teachers to treat students differently on the basis of the teacher’s experience with each student and to remain alert for what works. When differentiating among students, craft knowledge trumps science” p.185  You no doubt are familiar with Howard Gardner’s Theory of Multiple Intelligences. Unfortunately this theory has morphed into something that Gardner himself does not endorse, and you may know that he also disavows of the concept of matching students so-called intelligence with a teaching approach.  So, what is a teacher to do?  Teach that achievement comes from hard work and the proper application of knowledge (e.g. proper procedures, facts, etc). Teach the notion that intelligence is malleable and grows over time...it is not fixed at birth.  Teach content and curricular outcomes. A teacher should use their Program of Studies and prescribed curriculum outcomes and related content to decide how they are to teach. Remember the previous chapter that talked about helping students focus on what you want them to remember. Teachers need to know their content well and get students to think on this. Background knowledge is the key to how children engage with new material, not their preferred style of learning.  Teachers would be wise not to promote learning styles or intelligences...these distinctions, if not matched with the reality of life yet to be experienced, will leave students thinking that they are not going to be successful engaging with new material unless it fits their preferred learning style or intelligence...and that is simply not true. Effort is a stronger predictor of learning than a so-called learning style. | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **8** | Intelligence can be changed through sustained hard work | What do my students believe about intelligence? | Always talk about successes and failures in terms of process, not ability |
| **Chapter title: How Can I Help Slow Learners?**  Children do differ in intelligence, but intelligence can be changed through sustained hard work p.192  Both nature (genes) and nurture (environment) contribute to what we commonly refer to as intelligence. Now, Willingham goes into some detail in this chapter about general intelligence and the influence of our genes in determining this, but concludes this section with this thought: “genetic variations account for, at maximum, 20% of intelligence...” p. 198. That being said, genetic makeup may have an indirect influence on one’s disposition to certain things, like working hard, like seeking out particular environments, etc. It can be said that genes nudge you towards decisions but the amount of hard work and practice reap the benefit.  Gene pools change very slowly for a society over time....but research has shown that the IQ scores of citizens in several countries has risen due to changes in access to education, nutrition, schooling, literature, protection by law, etc. Environment and afforded access to learning has had a great impact on the rise of intelligence in my societies around the world. The lesson here is that we know that intelligence CAN be changed, it’s malleable and it can be improved.    **Teaching Application:**  Beliefs about one’s own intelligence actually matters to growth of intelligence. One’s attribution of success and failure (my effort or current knowledge vs. innate ability) and one’s orientation to the goals they set (performance goals to protect my reputation or get a good grade vs. goals to learn and grow and develop) have a huge impact on outcomes and growth in intelligence. Teachers play a huge role in helping students determine goals and learn about what causes them to be successful.  Okay, that’s fine, but reality is that some students seem to be slow learners and have deficits in intelligence...what do I do for them, will they catch up?  “The point of this chapter is to emphasize that slow learners are not dumb. They probably differ little from other students in terms of their potential. Intelligence can be changed” p.207. I realize, of course, that we cannot help but compare students to students...it’s what grades do, I guess. But looking at individuals as individuals and setting interim learning goals that are achievable and concrete is actually more important than where the student ends up compared to a peer. Reality is that some students will require substantially more work than others to ‘catch up’, and teachers know that there will not be extra time allotted in their busy schedules for these students. We must still emphasize that all students are still developing and growing....fostering a growth mindset and emphasizing the need for sustained hard work in life is important. Students need to be encouraged to think of life as a learning process that always requires readjustments and corrections...this is just normal and good.  First, you praise processes rather than ability. Recognize hard work and correct strategy use and focus on these for corrective feedback.  Second, encourage students to seek regular feedback as normal for learning and development  Third, help students become accustomed to changing course when they err...and provide accurate corrective feedback in this regard...don’t just praise them for hard work...show them where they erred and help them figure out what to do next.  Finally, see ‘catching up’ as a long term goal...and it is far better to teach students that learning is life-long, requires sustained hard work and our intelligence is malleable. | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **9** | Technology changes everything...but not the way you think | The changes to complex cognition brought about by tech are hard to predict | Don’t assume you know how new tech will work out in the classroom |
| **Chapter title: How Can I Know Whether New Technology Can Improve Student Learning?**  Everyone reading this sentence is probably at the age where we remember the induction of Smart phones and social media and high-speed internet and SmartBoards, etc. etc into our daily vocabulary and vicinity. For a few years now I’ve had students in my university classes who’ve never known a world without all of these technological advances. Are they digital natives, better able to access technology than I am and be ‘smart’ technologically. Well, as it turns out, not necessarily. “Comfort with tech comes from your context, not your generation”. P.220 That being said, we know that pre-teens to young adults are more apt to be motivated to understand and use platforms and devices used by their friends and those friends are usually willing tutors (p.220). The brain of this generation is not different than the brain of previous generations because of technology. The fundamental architecture of the mind has not changed. “Working memory capacity peaks in one’s early twenties and declines thereafter” (p.221) so the perception that students of this age are digitally advantaged stems more from their ability to task-switch (multitask) using various technology, but we mustn’t think they learn in a new way. “In other words, kids today are doing with tech more or less what I did at their age without it. Goofing off with their friends” p.233.  However, tech is having an influence on how children spend their time. Sleep may well be a victim of increased screen time and students (and adults) may well have lost some ability to delay gratification (wait until tomorrow to respond to a text? Never!).  **Teaching Application:**  Willingham offers a few suggestions to teachers and schools regarding technology and I’ll simply list them here:   1. Equity: think about what economically challenged families are able to do if you rely on hardware and internet speed and bandwidth for assignments. Schools should have a plan on how to help students who cannot afford these technologies 2. Adoption of Tech Products: Is a new technology or software product really going to help or improve your teaching? SmartBoards and various other technology sit idle in many classrooms as the promise was bigger than the result. Do your homework and be honest about the value of proposed tech. 3. Use tech to support children with disabilities. A lot has been done in technology to help children who need access to learning...schools are right to focus on this type of technology. 4. Have a consistent acceptable use policy for personal devices. Many teachers have had to try to fight the cellphone battle in their classes...when a school-wide policy can help tech find their full potential while not causing friction in other areas 5. Offer practice in sustained attention. “Paying attention is not just a matter of ability, it’s a matter of desire” p.244. We need to help our students learn the value of sustained attention past the point of distraction. 6. Education parents. Parents have varying levels of understanding and knowledge regarding the benefits and hazards of increased screen use and social media influence. It is a good idea to work with parents and develop a shared understanding around technology so that we have a partner-in-the-home to work with us to better manage and utilize the technology around us. | | | |
| **Chapter** | **Cognitive Principle** | **Required Knowledge about students** | **Most important classroom application** |
| **10** | Teaching, like any complex cognitive skill, must be practice to be improved | What aspects of my teaching work well for my students, and what parts need improvement? | Improvement requires more than experience; it also requires conscious effort and feedback. |
| **Chapter title: What About My Mind?**  “To think effectively, we need sufficient room in working memory, which has limited space. We also need the right factual knowledge and procedural knowledge in long-term memory” p.252.  Teaching is, of course, a combination of subject-matter knowledge, pedagogical content knowledge, interpersonal relationships and intrapersonal strength. To be good at teaching, teachers need to engage in deliberate practice of all elements of their craft. They also need to know the science of their craft and have a good understanding of the contextual environment in which they teach.  Key idea: like anyone who desires to be an expert, teachers must continually work on their craft to be continually improve.  Deliberate practice of your teaching (p.255)   1. You pick one small feature of the skill you know you don’t do very well and try to improve it, setting a specific goal, not a vague aspiration like ‘get better’ 2. As you practice, you get feedback from someone at least as knowledgeable about the skill as you are 3. You push yourself outside your comfort zone—you try new things 4. You find deliberate practice mentally demanding and candidly, not fun; and 5. You engage in activities that contribute to the skill indirectly   “If you want to be a better teacher, you can’t expect that improvement is a natural and unavoidable consequence of the experience you gain with passing years. You must engage in deliberate practice”(p.257).  Some other suggestions from Willingham:   * Record yourself and watch the videos with someone who will engage in the process of deliberate practice with you * Watch recordings of other teachers (readily available online) so you can practice the skill of observation and proper critique. Learn how to give feedback and how to make concrete the behaviours you observe. This will help you as you start to observe your own videos. * Focus on one skill at a time. Identify something you want feedback on and stick to that one skill. “I want to start my classes in such a way that I improve focusing the entire class’s attention on the outcome of the day”. * Bring your ideas back into your classroom and follow up on your progress. * Keep a teaching diary. Look for patterns....if you are having difficulty in certain areas look to see if there is a possible connection to a pattern in your teaching, or time of day, or surrounding events. You can learn a lot from reviewing your own observations in a diary. * Start a discussion group with your colleagues. This group might meet monthly at school or a coffee shop, during school hours or after school hours. The purpose is to create a supportive network of friends who help one another in their teaching. * Watching videos of yourself teaching and involving a trusted colleague in on the process is perhaps one of the most powerful tools you have in continual improvement of your teaching. * Improve your knowledge in your core subject area. Those who know their area best, teach best. | | | |

Source: Why Don’t Students Like School? Daniel T. Willingham (2021), pp. 276-277