15

BARAK ROSENSHINE

PRINCIPLES OF INSTRUCTION

LEARNING OUTCOMES

Having read this chapter you should be able to:

- understand Rosenshine's notion of principles of instruction
- be aware of his background as a person and as an educator
- consider the influence that other theorists have had on his ideas
- critically appraise his theoretical standpoint
- make links between theory and practice.

KEY WORDS

principles of instruction; modelling; cognitive psychology; metacognition; working and long-term memory; schemata; cognitive load theory; extraneous load; dual coding; scaffolding; cognitive apprenticeship

INTRODUCTION

Barak Rosenshine's work centred on teacher performance, student achievement and learning instruction. It is, however, his 2012 paper 'Principles of instruction: Research-based strategies that all teachers should know' for which he is most renowned. This paper sets out his ten most effective **principles of instruction**. In recent years these principles have had a major effect on education, including teacher training, as a structure for lessons and as an indicator of 'good teaching'; however, 'their context – and their evidence base – is poorly understood' (Powell, 2020: 20). Rosenshine, though, stated that the foundation for his principles of instruction spring from three sources: cognitive science (cognitive psychology), cognitive support learning strategies and research on effective classroom teaching (Rosenshine, 2012). The ideas from these three sources, Rosenshine reassures us, 'overlap and add to each other. This overlap gives us faith that we are developing a valid and research-based understanding of the art of teaching' (2012: 19). Nevertheless, there are questions surrounding the evidence base underpinning these principles as well as other criticisms of an ideological nature which will be explored later. Yet there is no doubt about the principles' acceptance and approval from teachers and school leaders as a framework for improving teaching and advancing learner achievement. The main reasons that Rosenshine's ten principles of instruction are highly valued by educators are that they are seen by many as containing the main characteristics of excellent teaching, their clear straightforwardness, and that they enable teachers to make links with educational research (Sherrington, 2019; Gibbs, 2020).

It is fitting at this early stage in the chapter that the ten principles of instruction are listed to get a feel of what follows:

1. Begin a lesson with a short review of previous learning: daily review can strengthen previous learning and can lead to fluent recall.
2. Present new material in small steps with student practice after each step: only present small amounts of new material at any time, and then assist students as they practise this material.
3. Ask a large number of questions and check the responses of all students: questions help students practice new information and connect new material to their prior learning.
4. Provide models: providing students with models and worked examples can help them learn to solve problems faster.
5. Guide student practice: successful teachers spend more time guiding students' practice of new material.
6. Check for student understanding: doing this at each point can help students learn the material with fewer errors.
7. Obtain a higher success rate: it is important for students to achieve a high success rate during classroom instruction.

8. Provide scaffolds for difficult tasks: the teacher provides students with temporary supports and scaffolds to assist them when they learn difficult tasks.
9. Require and monitor independent practice: students need extensive, successful, independent practice in order for skills and knowledge to become automatic.
10. Engage students in weekly and monthly review: students need to be involved in extensive practice in order to develop well-connected and automatic knowledge. (Rosenshine, 2012: 13–19)

Originally there were, what Rosenshine termed, seventeen Principles of Effective Instructions, and these are also included in his 2012 paper. However, they were abridged from seventeen to ten principles of instruction as a compromise with the *American Educator* journal editorial team. Sherrington (2019) has very helpfully transposed and condensed each of the principles above into four strands which help gather the principles into their main, and aligned, themes rather than the principles feeling like a long list. The strands are: sequencing concepts and **modelling**; questioning; reviewing material; and stages of practice. These strands will be employed later as a structure to consider some of the practical aspects of the principles of instruction.

The advice for classroom application set out in Rosenshine's 2012 paper would, it is suggested, appear to most teachers as good practical wisdom and a format many either seek to achieve or a format they already practise very effectively in their classrooms. Tom Sherrington, an advocate of Rosenshine's 2012 paper, observes that what attracts teachers to the principles of instruction is that 'there are no gimmicks, no fads, nothing that seems implausible, nothing outlandish' (Sherrington, 2019: 9). Further praise comes from Riches (2019), for their 'simplicity and logic … [and] … the way they link real-life classroom practice to more complex ideas surrounding **cognitive psychology**' (cognitive psychology is what Rosenshine [2012] terms 'cognitive science'). Nevertheless, although Rosenshine's principles of instruction suggest that it could be a perfect model to advance learning, there are some deeply held views on how students learn best. These viewpoints are generally split between two groups. The first group of educational thinkers have a more progressive viewpoint and they consider that students learn best when they are given the freedom to discover or construct some or all information themselves and with others. The second group of thinkers believe that students do best when given clear and precise instructional guidance from teachers on the what and how in order to complete learning tasks (Centre for Education Statistics and Evaluation [CESE], 2017). It is argued that Rosenshine's principles of instruction sit, for the most part, in the latter category. They are specifically related to the findings from cognitive psychology research, which will be explored when we examine the theory. But regardless of which approach Rosenshine's ideas come under, his principles of instruction paper has rapidly become a seminal work which has been adopted, with various degrees of conformity, by some initial teacher education courses and in school continuous development programmes (Enser, 2019a; Riches, 2019).

ROSENSHINE, THE PERSON

Barak Rosenshine was born in Chicago, Illinois in 1930, and died in Urbana, Illinois in 2017. He was Professor Emeritus in the Department of Educational Psychology at the University of Illinois. He gained his BA degree in psychology in 1957 from the University of Chicago, then became a high school history teacher for six years before leaving to study for a PhD in educational psychology at Stanford University, which he achieved in 1968. He then taught at Temple University before moving to the University of Illinois in 1971 (University of Illinois Archives, 2017; Edcentral, 2020).

Rosenshine wrote a number of journal articles about direct instruction, teacher performance and the application of cognitive classroom strategies. Rosenshine and Furst's (1971) research outcomes identified five effective characteristics of teacher behaviour. These findings acted as a basis for further research projects regarding teacher performance and student learning. Rosenshine and Stevens (1986) developed a six-function teaching model which outlined the instructional stages that were involved in students learning new skills (Clowes, 2002). These teaching functions were teacher-directed and skills-based, and described as direct instruction comparable, in form and content, with Rosenshine's principles of instruction (Carnine et al., 2004). Another important research study on teaching practice was published with Carla Meister; this paper explored the usefulness of scaffolds for teaching skills, and the value of scaffolds to support students in tackling higher-level thinking strategies (Rosenshine and Meister, 1994). A further collaborative work explored ways to help students create questions (Rosenshine et al., 1996). But the journal article which has had the biggest impact on teaching practice remains his 2012 paper 'Principles of instruction: Research-based strategies that all teachers should know'. The influence of the 2012 paper has been quite incredible in the educational community, with increasing commentary from journal articles in teaching publications to social media (Powell, 2020).

Much of his work is a result of collaborative research and writing. Moreover, it is contested that the principles of instruction are an amalgamation of research findings from a selective range of sources from mainly cognitive science (Rosenshine, 2012), rather than a stand-alone individual theory. Barak Rosenshine was an educator who enjoyed learning and being involved in research studies. He remained committed to his writing, which also included poetry and fiction, even after his formal retirement (Powell, 2020).

ROSENSHINE AND HIS NOTION OF PRINCIPLES OF INSTRUCTION

As previously mentioned, Rosenshine's principles of instruction is an amalgamation of his collaborative research and the work of others, mainly cognitive psychology based, educational thinkers. This section will consider the broader concepts of cognitive psychology which are interwoven within the principles of instruction, **metacognition**,

working and long-term memory and **schemas/schemata**, and then appraise the concepts of **cognitive load theory**, **extraneous load** and **dual coding**. Finally, the section will explore the notions of modelling and **scaffolding** – both of which are specific to two of the principles of instruction.

Cognitive psychology emerged as the influential school of thought in the first half of the twentieth century as a distinct break from behaviourism, which argued that learning was the result of 'how external stimuli led to learned responses' (Bartlett et al., 2001: 31). Cognitive psychology, however, recognised and examined the complexities involved in thinking, learning and problem solving, which included information processing, formation of schemata and the function of memory (Bartlett and Burton, 2020). A term central to Rosenshine's principles of instruction, particularly regarding their application, is metacognition: a term which roughly relates to the 'capacity to think about and manage one's own cognition' (Branigan and Donaldson, 2019: 792). Bruner further defines metacognition as 'what children think about learning and remembering and thinking (especially their own), and how "thinking about" one's own cognitive operations affects one's own mental procedures' (Bruner, 1996: 58). Metacognition, then, is the notion of a learner 'self-consciously examining his or her mental processes, becoming aware of problems and adjusting accordingly in order to improve effectiveness' (Child, 1997: 165).

Studies by the Centre for Education Statistics and Evaluation (CESE, 2017) indicate that instruction is more successful if it is specifically planned in line with how the learners process and store information. Indeed, the methods of remembering information underpin Rosenshine's principles of instruction, and involve both working and long-term memory. Working memory is initially the place where we process information; but working memory has limited space and can only handle a few bits of information at any one time. Overloading learners with information may cause confusion as their working memory will not be able to process it (Rosenshine, 2012). Working memory stores what we are thinking at the time and comes to us via our senses, mainly our ears and eyes. Then after storing and processing this information, it forgets much of it and is readily displaced by new information. However, there are occasions where working memory can transfer into long-term memory (Petty, 1998). Long-term memory has a virtually limitless space to store information and, as we shall see later, the ability to form schemata. Petty gives a very clear explanation of long-term memory:

> Long-term memory is like a super-efficient filing cabinet with information filed for future access. In order to pass into the long-term memory, information must first be processed and structured in the short-term [working] memory so that it 'makes sense' to the student. The process of structuring new information takes time; but it is time well spent, because students find it almost impossible to remember something that they do not properly understand. … If a student is given new information too quickly, he or she will not have time to process it properly in the short-term [working] memory, so the information will not be retained. (1998: 2)

It is worth noting as well that unless information in the long-term memory is used or recalled in some manner it too will become forgotten (Petty, 1998). It is the understanding of the relationship and connectivity between working and long-term memory which is central to the concept, and application, of the principles of instruction.

The key for retrieval from the senses is for the learner to organise information in a conceptually clear way. This organisation is conducted through the formation of schemata (schemata or schemas – plural; schema – singular) which are constructed in our minds from prior experience and knowledge, which are then employed to make connections with new information (see Figure 15.1). If, for example, a student is introduced to a new concept within an area of study, the teacher can try to explain the concept by making a connection with something they have previously studied within that subject, allowing the student to engage the relevant schema stored in the long-term memory (Bartlett and Burton, 2020). These schemata are 'mental structures abstracted from experience. ... They comprise sets of expectations which enable us to categorise and understand new stimuli' (Bartlett and Burton, 2020: 256). Sherrington clarifies this:

> We organise information into schemata. Typically, new information is only stored if we can connect it to knowledge that we already have. As a result, prior knowledge is a major factor in our capacity to learn new information. The more complex and interconnected our schemata are, the easier it is to make sense of new related information and the better we are to organise it so that it makes sense. ... This means that our schemata are more fully formed, are more interconnected, and can be explored and recalled more frequently. (Sherrington, 2019: 11)

Sherrington cautions that if the schema has flawed information, a misconception, then it needs to be unravelled and a new accurate schema recreated (Sherrington, 2019). Schemata are continually being reformed or altered as new experiences occur (Aubrey and Riley, 2019).

We have briefly considered the aspects of working and long-term memory, including the interaction between them, and that schemata are formed and stored in the long-term memory. We are now aware that the working memory has limited capacity to process new information, and if too much information is received it can result in overwhelming or overloading the working memory. This significant finding, which is specifically relevant to Rosenshine's principles of instruction, is a major feature of cognitive load theory. Cognitive load theory is defined by CESE (2017) as 'how the brain learns and stores knowledge', coming from the acknowledgement that:

> ... there is a limit to how much *new* information the brain can process at any given time ... [and, that] ... there are no known limits to how much *stored* information can be processed at any one time. The aim of cognitive load research is therefore to develop instructional techniques and recommendations that fit within the characteristics of working memory, in order to maximise learning. (CESE, 2017)

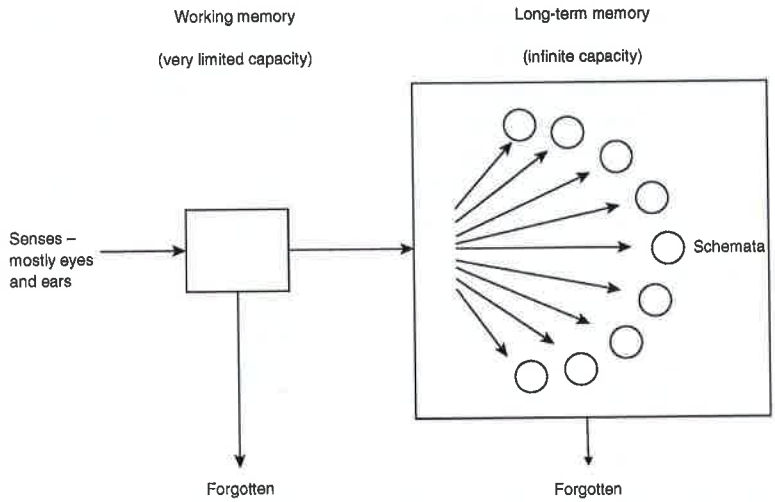

Figure 15.1 An abstract overview of information processing, working and long-term memory

(Adapted from Sherrington, 2019)

To maximise the learning, it is crucial that only information that is necessary for learning the subject matter, and the subsequent formation of schemata, is employed in the teaching process. Any information that is superfluous and does not directly influence the learning and the formation of schemata is termed extraneous load. As we will discover in the application section, this freeing up of the capacity of the working memory is a fundamental aim of the principles of instruction, particularly in the introduction of new knowledge (Rosenshine, 2012). The instructional design is the stage to ensure that it minimises the extraneous load 'in order to free up the capacity of the working memory' (CESE, 2017). A way to ease the extraneous load on the working memory is to take note of the dual code generalisation posed by Allan Paivio in the 1970s, who argued that memory is made up of two coding processes: visual-imagery (all that is seen) and verbal (all that is heard and read) (Reber and Reber, 2001; Enser, 2019a). Dual coding has some major consequences for teaching. Enser (2019a) offers two examples of these. Firstly, relating to the verbal process – asking students to read a text while listening to it being read aloud makes it challenging for them to focus. Secondly, for the visual-imagery process – although diagrams and graphics are positive supports to teacher talk, such images should be relevant to the taught topic and they should not be overfilled with information (Enser, 2019a).

The next two concepts are modelling and scaffolding and are specific to Rosenshine's principles of instruction numbers four and eight respectively. In some respects, both have similar purposes in developing and supporting learning, because the aim of these concepts is for the teacher to gradually let the student take more responsibility for

finishing the task at hand (Rosenshine and Meister, 1992). The practice of assisting students unravel and answer tricky problems by modelling and scaffolding is termed '**cognitive apprenticeship**'. Students learn strategies and content during this apprenticeship that enable them to become competent readers, writers, and problem solvers' (Rosenshine, 2012: 18). According to Enser (2019a: 61), 'modelling describes any process whereby we show someone what they should be doing'. Rosenshine (2012) contests that students need cognitive support to solve problems, and that:

> ... teacher modeling and thinking aloud while demonstrating how to solve a problem are examples of effective cognitive support. Worked examples (such as a math problem for which the teacher not only has provided the solution but has clearly laid out each step) ... allow students to focus on the specific steps to solve problems and thus reduce the cognitive load on their working memory. (2012: 15)

Sherrington (2019) suggests a number of ideas for where teachers can give models, such as connecting concepts with real-life examples, and connecting theoretical knowledge to experiential knowledge. Furthermore, Sherrington echoes Rosenshine's notion of 'thinking aloud' above. Modelling helps students 'in developing their capacity for metacognition and self-regulation by modelling their own thought processes'; and modelling assists students to process 'information into secure, well-structured schemata' (Sherrington, 2019: 20).

Scaffolding is a term coined by Lev Vygotsky and later refined by Jerome Bruner. It describes the help that is provided by an adult, or capable other, which allows the student to solve tasks which would otherwise be outside their level of ability. The idea is that when a student succeeds through scaffolding, they are then confident enough to try comparable tasks alone (Aubrey and Riley, 2019). Scaffolding is only beneficial within what Vygotsky (1978) termed the zone of proximal development (ZPD), which is the gap between what a student can achieve without assistance and what the student can achieve with assistance from an adult or capable other. As such, for scaffolding to be successful it is essential that the adult, or capable other, is mindful of the student's capabilities and receptive to their needs (Aubrey and Riley, 2019). Rosenshine (2012) emphasises the point that scaffolding is a temporary support mechanism which is gradually withdrawn when they become competent. However, he states that students may carry on using scaffolds when they are faced with especially tricky problems. Rosenshine also considers scaffolding to be a form of his fifth principle, guided practice, which is the antecedent for his ninth principle, independent practice (Rosenshine, 2012; Sherrington, 2019). Ideas for using scaffolding in the classroom will be explored in a later section of the chapter; however, both Rosenshine (2012) and Sherrington (2019) suggest that using prompts such as 'who', 'why' and 'how' helps students to ask questions during reading of texts. Other examples are the use of writing frames, the use of checklists, anticipating errors and misconceptions, by helping students to check and evaluate their work, and providing students with exemplars.

LINKS WITH OTHER THEORISTS

Rosenshine's ideas have clear links with the early cognitive psychologists whose thinking emerged during the twentieth century as an alternative to behaviourism. One person that can be closely associated with Rosenshine's principles of instruction is Frederick Bartlett, a British psychologist and an early exponent of cognitive psychology. Bartlett's 1932 work *Remembering: A study in experimental and social psychology* established the significant notion of '*schema* to account for the fact that we do not reproduce facts when we recall them, rather we reconstruct them' (Bartlett and Burton, 2020: 256). Another fellow American educational thinker and advocate for instructional methods of teaching was Siegfried Engelmann. Engelmann's notion of direct instruction is similar in structure and methods to Rosenshine's principles of instruction. Engelmann, with his colleague Douglas Carnine, set out their detailed theoretical overview of direct instruction, and ideas for practice, in their *Theory of Instruction: Principles and application* (2017). Both Engelmann's direct instruction and Rosenshine's principles have become very popular among teachers and policy makers of late; interestingly, they have also attracted a sizable degree of criticism (Morgan, 2020), which will be explored in the next section.

Rosenshine's notion of 'cognitive apprenticeship', where students (or novices) are helped 'by a master who models, coaches, provides support, and scaffolds them as they become independent' (Rosenshine, 2012: 18), has some commonality with a number of educational thinkers – although as a note of caution, for the most part it is argued that these thinkers have a stronger emphasis on the social and cultural influences underpinning their concepts. First are those who promote the benefits of apprenticeships as a learning and teaching process. Jean Lave and Etienne Wenger's 1991 influential work *Situated Learning: Legitimate peripheral participation* examined the advantages and difficulties of a range of apprenticeships. Their research found that apprenticeship was a complex concept which involved social interaction particularly when the learning became more difficult, and as mastery increased. It was not a mechanical process where the student (novice) simply reproduces the actions of the master (Aubrey and Riley, 2019). Apprenticeship is a theme which is frequently evident in Guy Claxton's work, particularly his concept of epistemic apprenticeship which is concerned 'centrally, with the activities of thinking, learning and knowing' (Claxton, 2012: 3) – which to some extent is aligned with Rosenshine and cognitive apprenticeship.

Scaffolding and modelling are also key elements in Rosenshine's idea of 'cognitive apprenticeship', and indeed they are major elements of his principles of instruction (2012). We have already commented upon Vygotsky being the originator of scaffolding, and ZPD, which was then refined for application in the classroom by Bruner, who based his enhanced notion on an engineering template. Bruner, like Rosenshine (2012), recognised that scaffolding was how apprenticeships functioned: 'A novice would be given small tasks at the margins of a complex task and, as mastery increased,

be given greater and greater responsibility' (Olson, 2007: 46). Aligned with this idea of scaffolding, learning should be a progressive process where teachers begin with what the student already knows and build on that knowledge, and there are similarities here with the work of Carol Dweck. Dweck's idea was to inspire students to embrace strategies which challenged their process of learning, similar to the concept of scaffolding. Both Vygotsky and Bruner also advanced the notion of modelling in the learning process. Links relating to Rosenshine's concept of modelling can be made too with the North American cognitive psychologist Albert Bandura. For Bandura, modelling was a series of events where learning takes place through observation and the replication of the actions of others. He argued that students are more inclined to model those they can associate with, 'or people they look up to as role models' (Aubrey and Riley, 2019: 145).

There are also associations in the use of checklists and the use of a wide empirical statistical research evidence base, similar to Rosenshine, with John Hattie and in particular with his seminal 2012 text *Visible Learning for Teachers: Maximizing impact on learning*. Like Rosenshine, Hattie's *Visible Learning* not only presents and analyses the research behind his findings but also offers some in-depth ideas for application in the classroom. Again, similar to Rosenshine, Hattie seeks to discover the most effective teaching and learning strategies: teaching is principally seen in 'terms of its impact on student learning' (2012: 1). Even though Rosenshine's work has connections with a number of educational thinkers and has received high accolades and levels of popularity of late, his work has also attracted significant criticism.

CRITIQUING ROSENSHINE'S IDEAS

Broadly speaking, the criticisms of Rosenshine's 2012 paper fall into two areas of concern: firstly, relating to the research, and secondly, qualms about ideology. Before these two areas are considered there is perhaps a general note of caution and thought surrounding his principles of instruction. Powell argues that Rosenshine's 2012 paper has evolved into something more than he ever envisioned it becoming: 'as something definitive, when it should be something we view with a lot more nuance' (Powell, 2020: 20).

Rosenshine set out to harvest the research of others, including his own, from three sources: research in cognitive science, research on master teachers, and research on cognitive supports (Rosenshine, 2012). In doing so Rosenshine certainly presents 'a highly accessible bridge between research and classroom practice. His principles are short, easy to read, and packed with insights' (Sherrington, 2019: 7). However, there is a danger in this brevity and accessibility, which, it is suggested, diminish and gloss over the specific research findings which his paper is based upon. The paper itself is convincing and easy to read, and when each of the ten principles are introduced it starts with the research findings – but there are no specifics about the research and indeed theory itself. Although there is a list of references, even more specific citations

could have helped give explicit links between 'research findings' and the source of that research. The presentation of the paper appears part magazine item and part peer-reviewed journal article. Therefore, there is a danger of oversimplifying the background theory, which could diminish the complexity of the research and as such be used as a short cut to practice. Mark Enser, an advocate of Rosenshine's principles of instruction, articulates this possible danger:

> We are reaching again for quick wins, and forgetting to really consider what underpins the ideas. We again are running the risk of losing significance of what we are doing and diluting the theory down to something unrecognisable and unhelpful. (Enser, 2019b)

There are also gaps relating to any limitations of the applications, such as use of the principles across curriculum subjects, differences between educational sectors, as well as any drawbacks that teachers should be aware of which emanated from the research he examined.

One of the ideological criticisms of the principles is that they represent a return to the traditional and didactic mode of teaching. In so doing they move away from the more learner-centred, discovery and experiential approaches of the progressive constructivist thinkers. This is an area of concern shared by quite a number of commentators on social media, 'who see Rosenshine as a Trojan Horse that is bringing a much more direct and traditional approach to teaching in schools' (Powell, 2020: 25). However, Mark Enser, in discussion with Powell (2020), suggests that Rosenshine's principles can be employed for most types of teaching. Moreover, in an early interview Rosenshine stated that experiential learning did have a place in the instructional process, but only after the students had 'mastered the basics' which were first provided by the teacher (Clowes, 2002). Another apprehension of the ten principles of instruction is that they can, albeit possibly mistakenly, be used as a lengthy checklist process where all of the principles are ticked off as they are employed by the teacher, which is counter to the thinking underpinning Rosenshine's 2012 paper (Riches, 2019). Deborah Gibbs argues that the ten principles are not a '"model lesson plan" to be repeated in every classroom' and all used in every lesson, rather they should be used as an aide memoire for the planning of lessons (Gibbs, 2020). There is also a danger that the use of the ten principles as a checklist in the evaluation of lessons could hinder teachers exploring new and creative approaches to their practice, which in turn may result in 'teachers … [going] … back to jumping through hoops rather than just getting on, teaching, teaching well and discussing how we are doing even better' (Enser, 2019b). Before we end this section of criticisms and progress to the next section on the application of the principles of instruction, it is perhaps timely to consider some very prudent advice about Rosenshine from Adam Riches:

> One of the best ways to engage with Rosenshine is to not think of the principles as a recipe; instead think of them as more of a number of potential ingredients that can be combined depending on need. (Riches, 2019)

APPLYING ROSENSHINE'S PRINCIPLES OF INSTRUCTION IN THE CLASSROOM

Rather than considering each of the ten principles (listed in the chapter introduction) in turn, this section will consider each of the ten principles within the abridged form of the four thematic strands created by Tom Sherrington (2019) below. To be true to the work of Rosenshine, and because of the limits of space within a single section of a chapter, it will mostly explore Rosenshine's own practical ideas for classroom practice from his 2012 article. Just as a word of caution with this, Rosenshine's article explores what 'effective teachers' do, and what the 'least effective teachers do'. The focus here will only be on what he considered as positive practice rather than comment on a deficit model, by using his views on what 'effective teachers' do. In accordance with the criticisms highlighted above, the principles should not be taken as a checklist to be ticked off, nor is it a template for lesson plans. There is also some repetition and blurring within the principles. For a fuller exploration of the application of Rosenshine's principles, Sherrington's 2019 short book *Rosenshine's Principles in Action* has a range of innovative practical examples related to the principles of instruction.

STRAND ONE: SEQUENCING CONCEPTS AND MODELLING

PRINCIPLE 2. PRESENT NEW MATERIAL USING SMALL STEPS

The essence of this is not only to introduce students to new information in small amounts, but to resist presenting the next point until the previous point has been understood. Any misunderstanding is retaught before new material is presented. Teaching in small steps is time consuming, but Rosenshine argues it is worth the effort to achieve positive learning outcomes. He cites research regarding mathematics teaching, where the teachers who were most successful 'spent about 23 minutes of a 40-minute period in lecture, demonstration, questioning, and working examples' (Rosenshine, 2012: 14). This gave an extra taught element, with additional examples, and checking understanding, enabling students to work independently. The successful teacher first taught in small steps, modelled the topic being taught, thought aloud and then supported students' practice; questioning took place during and at the end of the lesson.

PRINCIPLE 4. PROVIDE MODELS

Modelling is a form of cognitive support which helps students problem solve. Modelling is used during guided practice to foster student independence by the use of prompts and theoretical models, and through worked examples. Prompts by the teacher encourage students to ask questions about the task at hand, then students attempt the task on

their own with feedback from the teacher. 'This same procedure – providing a prompt, modelling, guiding practice, and supervising independent practice – can be used for many tasks' (Rosenshine, 2012: 15). Sherrington (2019) also advocates the use of conceptual models as a part of the modelling process. A third method of modelling is worked examples: these are effective in giving students the opportunity to concentrate on a particular stage of the problem at one time. This in turn decreases the cognitive load of the working memory. Rosenshine (2012) contends that worked examples are step-by-step demonstrations of how to solve a problem, and are particularly helpful in science and mathematics.

PRINCIPLE 8. PROVIDE SCAFFOLDS FOR DIFFICULT TASKS

Teachers helping students to tackle difficult tasks by modelling and scaffolding, as we have discovered, is termed 'cognitive apprenticeship'. There are close similarities between modelling and scaffolding – they are both temporary forms of cognitive supports, and they are types of guided practice. Each of the ideas for modelling mentioned can be used to provide scaffolding. Sherrington (2019) expands on the classroom practice ideas from Rosenshine's 2012 article, offering four ideas for scaffolding: the use of writing frames, exemplars, strategic thinking, and to anticipate errors and misconceptions. Rosenshine emphasised that successful teachers anticipated student errors and cautioned them about possible misconceptions. For example, regarding the use of checklists for students to evaluate their work, questions on the checklist could include: '"Have I found the most important information that tells me more about the main idea?" and "Does every sentence start with a capital letter?" The teacher then models the use of the checklist' (Rosenshine, 2012: 18).

STRAND TWO: QUESTIONING

PRINCIPLE 3. ASK QUESTIONS

Questioning is key to Rosenshine's principles of instruction, and its use is interwoven throughout all ten principles. He advocates using a large number of questions, listening to the students' answers and providing feedback. Questions assist students to apply new knowledge so they can make links with prior knowledge. Successful teachers, according to Rosenshine, devote over 50% of their teaching time to asking questions, lecturing and giving demonstrations. Questioning enables teachers to establish how much is being learned, and which areas need reinforcement. Successful teachers also ask their students to give an account of the process they used to find their answers and solve problems. It is important that all students are actively engaged in the process of answering questions, such as telling the answer to the student sitting next to them, or summarising key ideas of the question and communicating these to a fellow student, or by students swapping answers with each other (Rosenshine, 2012).

PRINCIPLE 6. CHECK FOR STUDENT UNDERSTANDING

Carrying out regular checks to assess learning of new material helps the process of transferring new learning into the long-term memory, and in highlighting misconceptions. Misconceptions can be reduced during guided practice:

> … asking students to summarize the presentation up to that point or to repeat directions or procedures, or by asking students whether they agreed or disagreed with other students' answers. This checking has two purposes: (a) answering the questions might cause the students to elaborate on the material they have learned and augment connections to other learning in their long-term memory, and (b) alerting the teacher to when parts of the material need to be retaught. (Rosenshine, 2012: 16)

Asking students to verbalise their thinking as they solve problems, then asking them to justify their solutions, adds depth to their knowledge and highlights misunderstandings (Rosenshine, 2012). Sherrington proposes that questions should always be framed as 'Can you tell me what you have understood?' rather than 'Have you understood?', as it gives a good indication of students' level of understanding, and provides feedback to the teacher on their effectiveness (Sherrington, 2019: 33).

STRAND THREE: REVIEWING MATERIAL

PRINCIPLE 1. DAILY REVIEW

Rosenshine explains that daily practice of reviewing previous learning is one part of helping students acquire an expertise in the taught subject. It supports the recall of 'words, concepts, and procedures effortlessly and automatically … to solve problems or to understand new material' (Rosenshine, 2012: 13). For example, seeing words as a single unit without having to sound out each letter frees up space in the working memory, allowing for deeper understanding. He suggests that teachers should start their lessons with a five-to-eight-minute review of prior learning relevant to the day's lesson, including the rehearsal of details and skills, which promotes recall becoming automatic. If previous learning is not reviewed daily, students find it difficult to learn new knowledge (Rosenshine, 2012). Rosenshine offers the following ways to provide daily reviews:

- Correct homework.
- Review the concepts and skills that were practiced as part of the homework.
- Ask students about points where they had difficulties or made errors.
- Review material where errors were made.
- Review material that needs overlearning (i.e., newly acquired skills should be practiced well beyond the point of initial mastery leading to automaticity).

(Rosenshine, 2012: 13)

PRINCIPLE 10. WEEKLY AND MONTHLY REVIEW

Rosenshine argues that students need to engage in wide-ranging reading and practice to develop their overall learning. When there is a deep level of subject knowledge stored in the long-term memory, learning new material becomes effortless; it also (again) frees space in the working memory. Rosenshine advises that weekly learning could be reviewed every Monday; monthly learning reviewed every fourth Monday. Weekly and monthly reviews could be in the form of tests or quizzes. These reviews should be thoroughly practised to prevent knowledge being forgotten (Rosenshine, 2012).

STRAND FOUR: STAGES OF PRACTICE

PRINCIPLE 5. GUIDE STUDENT PRACTICE

Outcomes from information processing research stress that students should spend extra time 'rephrasing, elaborating, and summarising new material to store in their long-term memory' (Rosenshine, 2012: 16). When using guided practice Rosenshine and Meister (1992) suggest that teachers begin with easier tasks and slowly increase the level of difficulty, allowing students to be active participants from the outset. Short teacher presentations are used first before guiding student practice by giving examples, checking understanding and using modelling and scaffolding to enable students to then work independently. By providing plenty of time on guided practice, students are better prepared for independent practice, and achieve high success rates during classroom instruction.

PRINCIPLE 7. OBTAIN A HIGH SUCCESS RATE

Guiding student practice is the key to students gaining high success rates. For Rosenshine the best possible success rate for developing student achievement is in the region of 80%, which he argues demonstrates deep learning, and students are challenged. Sherrington, however, suggests that the 80% is 'unrealistic to achieve in a mixed-attainment class, minute by minute' (Sherrington, 2019: 45). If guided practice does not yield such a high success rate, it is probable the students are practising errors. Errors and misconceptions are likely if new material is taught all at once rather than in small steps, and if checking of understanding is infrequent (Rosenshine, 2012).

PRINCIPLE 9. INDEPENDENT PRACTICE

Independent practice is the point where teachers start handing over responsibility for learning to the students, to tackle difficult problems on their own. Students draw upon their long-term memory, make connections, produce their own feedback, and develop

their own learning targets (Sherrington, 2019). Teacher-led guided practice is followed by independent practice where students exercise their skills in developing and enhancing new knowledge to become fluent. Independent practice can take place in the classroom, or as homework. Rosenshine stresses that independent practice should contain relevant material used in guided practice. He also highlighted that students should be fully prepared before beginning their independent practice. Preparation, during guided practice, could be bolstered by asking students to explain the material to fellow classmates, which he called cooperative learning. Cooperative learning affords students receiving feedback from their peers regarding the accuracy, or otherwise, of their responses (Rosenshine, 2012).

OVERVIEW OF APPLICATION: IDEAS FOR USING ROSENSHINE'S PRINCIPLES OF INSTRUCTION

Sherrington gives a concise and structural outline of the process of the learning experience using the principles of instruction:

- Teacher explains.
- Teacher models.
- Teacher checks understanding.
- Student engages in guided practice with scaffolding as needed.
- Scaffolding and support are gradually withdrawn.
- Student engages in independent practice.
- Student becomes fluent.

(Sherrington, 2019: 45-6)

SUMMARY

Barak Rosenshine was an American educator and psychologist whose research encompassed teacher performance, student achievement and learning instruction. His research was the product of working with other like-minded scholars. Rosenshine has gained remarkable recognition of late for his principles of instruction, published in a 2012 paper. The paper explored the research findings from three sources: cognitive science, cognitive support learning strategies, and research on effective classroom teaching. In short, the theoretical underpinning is based on information processing including the working and long-term memory. The chief reasons why his principles of instruction are in vogue and valued by some teachers are that they are perceived to reflect the characteristics of excellent teaching, they are straightforward,

and they facilitate links between teachers and educational research (Sherrington, 2019; Gibbs, 2020). Conversely, the principles of instruction are considered by others as a return to traditional teaching, at the expense of the more progressive student-centred approach.

Rosenshine's ideas have firm associations with early cognitive psychologists. One such cognitive psychologist was the British scholar Frederick Bartlett, who explored the function of schemata in reconstructing information. There are close similarities between Rosenshine's work in general, and particularly his principles of instruction, and Engelmann's idea of direct instruction. The concept of cognitive apprenticeship where the novice is taught by the expert is aligned with the work and research of Jean Lave and Etienne Wenger, specifically their 1991 text *Situated Learning: Legitimate peripheral participation*. Furthermore, it is also comparable with Guy Claxton's concept of epistemic apprenticeship. His use of scaffolding was first proposed by Vygotsky, and then refined by Bruner; and modelling has overtones with the work of Albert Bandura. There are further links with John Hattie's research, which strives to discover the most effective teaching strategies that have an impact on student learning.

Criticisms of Rosenshine's principles of instruction fall into two categories: first concerning the research methodology, second regarding ideology. Teachers have valued the link between teachers and educational research. However, there is a danger that the straightforwardness, brevity and accessibility of Rosenshine's 2012 principles of instruction paper gloss over the precise findings that the paper was founded upon. This, then, could oversimplify the research and theory involved and in so doing weaken the intricacy of the research, resulting in possible shortcuts being taken in practice (Enser, 2019b). Further ideological censures include the concern that the principles could be used as a lesson checklist where points are ticked off as they are used by the teacher. The popularity of the principles of instruction is unquestioned; however, there is a possibility that they have developed into a phenomenon which Rosenshine never intended when he wrote the paper. They have become something conclusive, rather than something which should be treated with more subtlety (Powell, 2020).

GLOSSARY OF TERMS

Cognitive apprenticeship

This is where students, or novices, are assisted in their learning development by a teacher 'who models, coaches, provides support, and scaffolds them as they become independent' (Rosenshine, 2012: 18). Modelling and scaffolding are important elements of cognitive apprenticeship, and both are key practical aspects of Rosenshine's principle of guide student practice.

Cognitive load theory

This theory is defined as 'how the brain learns and stores knowledge' (CESE, 2017). It is concerned with the recognition that there is a defined limit on the amount of new information that the brain can process at one time (working memory). Conversely there are no such limits on how much stored information (long-term memory) can be processed at one time. Cognitive load theory has an impact for teachers so they can help students develop effective techniques in processing new material. Such techniques should take into account the impact on the cognitive load of their working memory (CESE, 2017).

Cognitive psychology

Cognitive psychology appeared during the first half of the twentieth century as a break with behaviourism. As a science it acknowledged and explored the complexities that take place during thinking, learning and problem solving, which included information processing, formation of schemata and the function of memory (Bartlett and Burton, 2020).

Dual coding

This notion posits that memory contains two coding processes: visual-imagery (all that is seen) and verbal (all that is heard and read). Dual coding has important consequences for teaching, particularly for instructional design: too much information, either visual or verbal, and the working memory is in danger of being overwhelmed (see below).

Extraneous load

This refers to a cognitive load which is superfluous to the subject being taught and as such does not directly influence learning and the formation of schemata. Extraneous load is a strain on the capacity of the working memory. Therefore, teachers should reduce any extraneous load when they plan lessons to make room in the working memory for information that is explicitly relevant to the subject being taught.

Metacognition

This is defined by Bruner as 'what children think about learning and remembering and thinking (especially their own), and how "thinking about" one's own cognitive operations affect one's own mental procedures' (Bruner, 1996: 58). In doing this the child can scrutinise their own learning processes and make appropriate adjustments to enhance effectiveness (Child, 1997).

Modelling

At a basic level modelling is any activity where a teacher or a capable other demonstrates what a student should be doing (Enser, 2019a). Modelling is a form of cognitive

support which can take the form of thinking aloud to solve problems, using worked examples, and linking ideas with real-life cases. When teachers use modelling, similarly to scaffolding, their goal is to gradually step back and allow students to gain a greater degree of confidence and responsibility for completing the task, or solving the problem. Modelling plays a key role in Rosenshine's guide student practice principle.

Principles of instruction

These are the ten most effective principles of instruction set out in Rosenshine's influential 2012 paper: 'Principles of instruction: Research-based strategies that all teachers should know.' The foundations of these principles spring from three research-based sources: cognitive science, cognitive support learning strategies and effective classroom teaching. These ten principles have become popular of late and valued by many teachers because they are seen as containing the major characteristics of excellent teaching. They are clear and straightforward, and allow teachers to connect with educational research (Sherrington, 2019; Gibbs, 2020).

Scaffolding

This is a type of cognitive support where the help from the teacher, or capable other, facilitates the student to achieve a task or solve problems which would otherwise be beyond their level of capability. Scaffolding is only valuable within the zone of proximal development, which is the gap between what the student can achieve without assistance and what the student can achieve from the teacher or a capable other. Like modelling, scaffolding is only a temporary support, which is withdrawn when the student becomes competent. It also plays a key role in Rosenshine's guide student practice principle.

Schemata

Schemata are like a network of connections which are key for the organisation of information. They are constructed in the long-term memory from prior experience and stored knowledge, which in turn is used to make connections with new information. In practice these connections can be facilitated by a teacher when they are introducing a new idea within an area of study by making links with something they have already studied, allowing the student to engage the relevant schema.

Working and long-term memory

Working memory is the place where information is initially received and processed. Working memory, though, has a limited capacity, and overloading learners with too much information can create confusion. However, working memory can be processed and structured into the long-term memory, which has limitless space and the ability to form schemata.

FURTHER READING

Christodoulou, D. (2016) *Making Good Progress? The future of assessment for learning*. Oxford: Oxford University Press.

A research-based analysis of formative assessment used in classrooms. Includes practical ideas for teachers to develop their skills of ongoing feedback during lessons.

Dweck, C. (2010) Even geniuses work hard. *Educational Leadership, 68*(1), 16–20.

Explores thoughts on giving students feedback on assessed tasks which empowers and motivates them to make progress in their learning and in grade improvement; in effect, that learning is developed through guided application.

Willingham, D. (2009) *Why Don't Students Like School? A cognitive scientist answers questions about how the mind works and what it means for the classroom*. San Francisco, CA: Jossey-Bass.

Provides hands-on ideas which explore what makes outstanding and unforgettable lessons from a cognitivist scientist's viewpoint.

REFERENCES

Aubrey, K. and Riley, A. (2019) *Understanding and Using Educational Theories* (Second Edition). London: Sage.

Bartlett, F. (1932) *Remembering: A study in experimental and social psychology*. Cambridge: Cambridge University Press.

Bartlett, S. and Burton, D. (2020) *Introduction to Education Studies* (Fifth Edition). London: Sage.

Bartlett, S., Burton, D. and Peim, N. (2001) *Introduction to Education Studies*. London: Paul Chapman.

Branigan, H. and Donaldson, D. (2019) Learning from learning logs: A case study of metacognition in the primary school classroom. *British Educational Research Journal, 45*(4), 791–820.

Bruner, J. (1996) *The Culture of Education*. London: Harvard University Press.

Carnine, D., Silbert, J., Kame'enui, E. and Tarve, S. (2004) What is Direct Instruction? In: *Direct Instruction Reading* (Fourth Edition), New York: Pearson, Allyn & Bacon, Prentice Hall. Available from: www.arthurreadingworkshop.com/wp-content/uploads/2018/04/DIReading.pdf [accessed 12 October 2021].

CESE (Centre for Education Statistics and Evaluation) (2017) *Cognitive load theory: Research that teachers really need to understand*. September. Available from: www.havelockprimaryschool.com/wp-content/uploads/2018/11/cognitive-load-theory-VR_AA3.pdf [accessed 3 October 2020].

Child, D. (1997) *Psychology and the Teacher* (Sixth Edition). London: Cassell.

Claxton, G. (2012) *Schools as an epistemic apprenticeship: The case of building learning power*. Education Section of the British Psychological Society's 32nd Vernon-Wall Lecture.

Clowes, G. (2002) What characterizes an effective teacher? An exclusive interview with Barak Rosenshine. *School Reform News*, 1 May. Available from: www.formapex.com/barak-rosenshine/615-what-characterizes-an-effective-teacher-an-exclusive-interview-with-barak-rosenshine [accessed 21 October 2021].

Edcentral (2020) *Barak Rosenshine*. Available from: https://edcentral.uk/edblog/expert-insight/a-beginners-guide-to-professor-barak-rosenshine [accessed 21 October 2021].
Engelmann, S. and Carnine, D. (2017) *Theory of Instruction: Principles and application* (Revised Edition). Eugene, OR: NIFDI Press.
Enser, M. (2019a) *Teach Like Nobody's Watching: The essential guide to effective and efficient teaching*. Carmarthen: Crown House.
Enser, M. (2019b) The dangers of Rosenshine. *Teaching it Real*. Available from: https://teachreal.wordpress.com/2019/04/12/the-dangers-of-rosenshine%EF%BB%BF/ [accessed 21 October 2021].
Gibbs, D. (2020). How Rosenshine can help – or rob us of teacher freedom. *The Times Educational Supplement*, 18 February. Available from: www.tes.com/news/how-rosenshine-can-help-or-rob-us-teacher-freedom [accessed 21 October 2021].
Hattie, J. (2012) *Visible Learning for Teachers: Maximizing impact on learning*. Abingdon: Routledge.
Lave, J. and Wenger, E. (1991) *Situated Learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
Morgan, J. (2020) (Mis)directed learning. *The Times Educational Supplement*, 30 October, 18–25.
Olson, D. (2007) *Jerome Bruner*. London: Bloomsbury.
Petty, G. (1998) *Teaching Today* (Second Edition). Cheltenham: Nelson Thornes.
Powell, J. (2020) In search of the real Rosenshine. *The Times Educational Supplement*, 4 September, 18–25.
Reber, A. and Reber, E. (2001) *The Penguin Dictionary of Psychology* (Third Edition). London: Penguin.
Riches, A. (2019) NQTs: Want to be a great teacher? You need to read this. *The Times Educational Supplement*, 3 June. Available from: www.tes.com/news/nqt-teacher-school-training-cpd-instruction [accessed 31 August 2020].
Rosenshine, B. (2012) Principles of instruction: Research-based strategies that all teachers should know. *American Educator*, Spring, 12–39.
Rosenshine, B. and Furst, N. (1971) Research on teacher performance criteria. In Smith, B.O. (ed.) *Research in Teacher Education: A Symposium*. Englewood Cliffs, NJ: Prentice Hall.
Rosenshine, B. and Meister, C. (1992) The use of scaffolds for teaching higher-level cognitive strategies. *Educational Leadership*, *49*(7), 26–33.
Rosenshine, B. and Meister, C. (1994) Reciprocal reading: A review of the research. *Review of Educational Research*, *64*(2), 479–530.
Rosenshine, B. and Stevens, R. (1986) Teaching functions. In: Witrock, M. (ed.) *Handbook of Research on Teaching* (Third Edition). New York: Macmillan.
Rosenshine, B., Meister, C. and Chapman, S. (1996) Teaching students to generate questions: A review of the intervention studies. *Review of Educational Research*, *66*(2), 181–221.
Sherrington, T. (2019) *Rosenshine's Principles in Action*. Woodbridge: John Catt.
University of Illinois Archives (2017) *Barak Rosenshine (1930–2017)*. Available from: https://archon.library.illinois.edu/?p=creators/creator&id=3042 [accessed 25 September 2020].
Vygotsky, L. (1978) *Mind in Society*. Cambridge, MA: Harvard University Press.