Using Gagne’s theory to teach procedural skills

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SUMMARY
Background: Many key medical procedures are performed every day in clinical practice to yield important diagnostic information and to help determine the disease response to intensive treatments. Training clinicians to perform procedures competently and confidently thus carries considerable weight, helping to assure patient safety, the obtainment of adequate samples and minimising patient discomfort. This article considers how Robert Gagne’s instructional design model may be effectively used to design lesson plans and teach procedural skills in small group settings.

Context: Gagne’s model is based upon the information-processing model of mental events that occur when adults are presented with various stimuli. It highlights nine specific instructional events, which correlate with crucial conditions of learning, and are arranged to maximally enhance the learning process, improve session flow and, ultimately, ensure lesson objectives are comprehensively addressed.

Innovation: This article uses the nine points described by Gagne to outline a comprehensive lesson guide for teaching psychomotor skills, using a bone-marrow aspirate procedure as an example. Each of Gagne’s instructional events is considered with specific activities for each, and with the variety of activities delineated to meet diverse learning styles.

Implications: Gagne’s instructional events can produce an effective and comprehensive lesson plan for teaching procedural skills, preparing learners with various preferred learning styles to perform psychomotor skills competently in clinical practice. This lesson plan can be of use for both teachers and students across clinical specialties, encouragingly outlining how Gagne’s systematic and widely referenced theory can be creatively and practically used.
**INTRODUCTION**

Gagne’s instructional design model, widely attested in educational circles, is based upon the information-processing model of mental events that occur as adults are presented with various stimuli.¹⁻³ It delineates a sequence of specific instructional events that correlate with crucial conditions of learning, providing a model that is able to maximally enhance the learning process, improve session flow and ensure objectives are comprehensively addressed.

This article innovatively considers how Gagne’s instructional design may be effectively adapted to teach practical psychomotor skills in small group settings. A variety of potential activities are explored for each instructional stage, with a special focus on meeting diverse learning styles in order to optimise skill acquisition for all.⁴⁻⁵ The specific psychomotor skill of obtaining a bone-marrow aspirate is used as an example, to enable a fuller appreciation of application in the clinical setting.

### GAGNE’S INSTRUCTIONAL DESIGN

Robert Gagne first published the book *The Conditions of Learning* in 1965, now in its fourth edition. In essence, Gagne describes nine instructional events, to be followed sequentially, designed to enhance learning by mapping onto key elements of the adult learning process (Table 1).¹

### APPROACHING GAGNE’S MODEL

Categorising the type of learning outcomes to be achieved is an initial consideration. Gagne identified five broad divisions (Box 1), with procedural skills most obviously corresponding to motor skills, as well as psychomotor and affective skill outcomes.¹⁻³⁶

Elucidating underpinning foundational understanding is key, with specific thought given to assumed ‘prerequisite components’. For example, the ‘prerequisite components’ for performing a bone-marrow aspiration would be:

- knowledge of pelvic bone anatomy;
- knowledge of basic bone marrow physiology and haematopoiesis;
- understanding the basic role of bone marrow examination;
- proficiency in universal precautions and aseptic techniques;
- proficiency in injecting a local anaesthetic safely;
- an understanding of informed consent.

Appreciating the relationship of various topic parts and establishing a formalised procedural hierarchy, with the constituent steps ordered clearly, is also required (Table 2).

### CREATIVELY APPLYING GAGNE’S MODEL TO PRACTICAL PROCEDURES

Each of Gagne’s events will now be considered in turn, illustrating how each may be adapted to teach procedural skills.

#### 1. Gaining attention

For maximal learning, full learner attention should be captured and interest aroused, as curiosity motivates learning.² Simultaneously targeting visual, auditory

<table>
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<th>Table 1. The adult learning process⁹</th>
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<td><strong>Instructional event</strong></td>
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<td>1. Gaining attention</td>
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<td>2. Informing learner of objectives</td>
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<td>3. Stimulating recall of prior learning</td>
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<td>6. Eliciting the performance</td>
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<td>9. Enhancing retention and transfer</td>
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<table>
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<tr>
<th>Box 1. Gagne’s learning outcomes</th>
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<tr>
<td>1. Intellectual skills</td>
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<tr>
<td>• Discriminations</td>
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<tr>
<td>• Concrete concepts</td>
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<tr>
<td>• Defined concepts</td>
</tr>
<tr>
<td>• Rules</td>
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<tr>
<td>• Higher-order rules (problem solving)</td>
</tr>
<tr>
<td>2. Verbal information</td>
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<td>3. Cognitive strategies</td>
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<td>4. Motor skills</td>
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<td>5. Attitudes</td>
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and kinetic domains is advantageous. Potential techniques include:

- an abrupt opening auditory stimulus: i.e. speaking loudly;
- posing thought-provoking true-or-false procedural questions, and asking learners to move to either side of the room to show their opinion;
- projecting related slides, with learners voting to express judgment, i.e. pathology slides and specimens, voting between ‘pathological’ and ‘normal’: the use of multimedia can positively integrate visual and sound stimuli.2

2. Informing learners of objectives
Presenting learning objectives establishes expectancy, provides a framework for advanced organisers and sets a valuable standard, against which learners can self-assess and self-regulate.2

Objectives should be phrased with an introductory statement, such as ‘upon completing this session you will be able to…’, followed by clearly defined expectations that are measurable and achievable.2 For example, rather than providing a vague goal of ‘understanding patient care requirements surrounding the procedure’, clearer, specific objectives would be ‘you will be able to explain the indications for and risks of the procedure’ and ‘you will be able to describe post-procedural care requirements’.

Importantly, one should refrain from simply listing teacher objectives, as only meaningful interaction with goals adds weight to the learning experience, and dynamically defining joint learning objectives further aids learner participation and collaboration. Techniques to facilitate this interaction include revealing objectives sequentially, asking different group members to read aloud, providing an opportunity for questioning and providing clarity before continuing. It can also be helpful to ask the group to consider which, if any, they feel they could already achieve at the outset to establish pre-instruction competence, and likewise, which they feel are more difficult so that special focus can be given to reviewing attainment in this area. This technique certainly illuminates the need to know, harnessing the ‘internal drive’ to learn,8 an important value within the famous Knowles’ adult learning principles.

3. Stimulating recall of prior learning
According to cognitive informative processing theory, most new learning depends on connections with prior learning and experiences.8 Interactive group discussion, which specifically enquires about previous procedure attempts, experience from observation or feedback from patients, can facilitate such recall.2,3

Elucidating an understanding of the disease relevant to the procedure helps contextualise learning, which is pertinent for adult learners (e.g. exploring respiratory diseases when teaching arterial blood gases, or the causes of pleural effusions when teaching chest drains).8–10 Challenging the need for the procedure further augments this process, encouraging clinical reasoning through asking ‘why perform an arterial blood gas, how will it help?’, ‘what can be deduced from the protein level of pleural fluid, how could it change management?’. Documenting group responses visually on a mind map builds knowledge, with collaborative brainstorming particularly suited to activists.11

Considering procedural test results collectively can heighten relevance and build knowledge: e.g. projecting bone marrow aspirate slides illustrating a range
of disease and asking learners to identify arrowed cells, or discussing a series of arterial blood gas results. Building knowledge in this piecemeal fashion particularly suits theorists. Eliciting the required knowledge of related anatomy is also important. A potential activity, suited to kinaesthetic learners and visual/spatial intelligences, involves passing around life-size models of the

<table>
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<th>Table 3. Potential sequential activities and relevance to various learning styles when teaching a bone marrow aspirate</th>
<th>Objective</th>
<th>Activity/activities</th>
<th>Learning styles suited</th>
</tr>
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<tbody>
<tr>
<td>Explaining indications/risks</td>
<td>Title only shown: ‘Indications’. Learners proffer answers until most are exhausted. Comprehensive list subsequently revealed, along with incidences, to contextualise information. Repeated for ‘Risks’. Video of obtaining consent, including discussion of risks/indications</td>
<td>Activists – enjoy challenges/brainstorming&lt;sup&gt;11,14&lt;/sup&gt; Reflectors – appreciate observing processes&lt;sup&gt;14&lt;/sup&gt; Visual/auditory learners&lt;sup&gt;15&lt;/sup&gt;</td>
<td></td>
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<tr>
<td>Identifying equipment</td>
<td>Pre-prepared tray shown, with equipment explained in procedural order. Unfamiliar equipment passed around.</td>
<td>Visual-spatial/kinaesthetic intelligences&lt;sup&gt;11&lt;/sup&gt;</td>
<td></td>
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<td>Correctly position patient/identify site for procedure</td>
<td>Teacher positions volunteer, clearly articulating instructions. Teacher explains and demonstrates technique for identifying landmark. Learners then palpate for themselves, gaining tactile appreciation.</td>
<td>Visual-spatial/kinaesthetic intelligences&lt;sup&gt;11&lt;/sup&gt; Pragmatists – opportunity to try technique&lt;sup&gt;11,14&lt;/sup&gt;</td>
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<tr>
<td>Administer local anaesthetic</td>
<td>Safe administration practice reiterated. Technique for deeper infiltration around periosteum slowly explained as a new technique. An illustrated video diagrammatically demonstrating needle angle/technique may also be used constructively.</td>
<td>Visual/auditory learners&lt;sup&gt;11,14&lt;/sup&gt;</td>
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<td>Extract bone marrow aseptically</td>
<td>A step-by-step pre-recorded tutorial can be highly effective, combining audio of a clinician explaining the varying resistances felt, with corresponding sagittal diagrams showing what is happening inside.</td>
<td>Visual/auditory learners&lt;sup&gt;11,15&lt;/sup&gt; Reflectors – appreciate performer perspective&lt;sup&gt;14,16&lt;/sup&gt;</td>
<td></td>
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<tr>
<td>Label accurately</td>
<td>Correctly labelled replica samples and laboratory forms are shown, followed by incorrectly labelled samples/forms, asking learners to identify any errors.</td>
<td>Theorists – enjoy analysis&lt;sup&gt;11&lt;/sup&gt; Activists – enjoy challenge&lt;sup&gt;11,14&lt;/sup&gt;</td>
<td></td>
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<tr>
<td>Documentation</td>
<td>Exemplary recording discussed.</td>
<td>Reflectors – enjoy low-profile consideration&lt;sup&gt;15&lt;/sup&gt;</td>
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<td>Post-procedure care</td>
<td>Learners asked what they would tell the patient, before showing list of the care required and potential complications.</td>
<td>Pragmatists – enjoy brainstorming&lt;sup&gt;11&lt;/sup&gt;</td>
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appropriate anatomical area, with each learner tasked to name or identify anatomical landmarks.

4. Presenting the stimulus material
New content should be organised meaningfully, systematically addressing each learning objective, and should be delivered using a variety of media. To illustrate the process, objectives have been identified and potential activities proposed for the example of bone marrow aspiration (Figure 1). This can hopefully serve as a general guide, as several objectives, together with the activities proposed, are readily transferable to other procedural skills (Table 3).

5. Providing learning guidance
When teaching psychomotor skills, the direct observation of correct performance emboldens learners. A real-time demonstration on a replica dummy is thus particularly helpful. Initially, perform the procedure whilst explaining each step, providing tips and memorisation techniques, such as mnemonics or analogies, which help learners semantically encode and transfer learning to their long-term memory. The full procedure should then be performed uninterrupted, providing a role model against which learners can self-assess, especially valued by reflectors.

6. Eliciting the performance
The primary focus is now on procedural practice. Small group practice with indirect supervision affords the flexibility to focus on aspects of difficulty, with collaboration developing understanding and suiting activists especially. Following this, a ‘hot-seat’ approach, whereby each learner performs the procedure with the group observing, can be effective: articulating a non-threatening coaching atmosphere.

7. Providing feedback
Immediately after observing each learner perform the procedure, give specific objective feedback, using a model such as Pendleton’s rules (Box 2).

Such feedback provides encouragement and promotes social learning, with reflectors thriving on observing others.

8. Assessing the performance
Each learner should now demonstrate the procedure without guidance. Formalised feedback carries considerable weight – thus a written record, highlighting competence and recommending areas for self-directed practice, can be particularly helpful, especially for analytical theorists who tend to be perfectionists.

9. Enhancing retention and transfer
Ways to develop increasing procedural proficiency, such as spaced reviews, practice logbook and further supervision opportunities within the clinical skills environment, should be outlined. Ultimately, however, models in an artificial teaching environment have inevitable limitations, and therefore learners must transfer skills to the clinical setting for full competence. Identifying supervised procedural opportunities in clinical areas, affording opportunities for skill transference, is therefore of great value.

Box 2. Providing feedback using Pendleton’s Rules
- Learner initially identifies performance strengths
- Group is asked what they observed went well
- Teacher discusses observations of what they perceived as performance strengths
- Learner asked what went less well, and what they would do differently next time
- Group reports their observations on areas of weakness
- Teacher recommends what could be done differently next time
EXPERIENCE FROM PRACTICE

While creatively developing Gagne’s model to teach psychomotor skills, I have found the general approach and structure outlined herein can be easily applied to multiple clinical skills across specialties. The research explored, proposed activities, hints and tips included have since served as a model, allowing me to develop engaging lesson plans that systematically address key learning events in an ordered and evidenced manner.

Notably, this model avoids the common pitfall of teaching procedures as isolated entities, with procedural understanding instead embedded in real-life application and relevance. Indeed, students have specifically reported feeling enabled not only to perform the procedure but also to firmly understand indications and the interpretation of basic results, with this positively generating increased learner enthusiasm. Certainly, promoting conscientious, questioning clinicians who employ clinical reasoning as they approach practical procedures is a great asset of this model.

CONCLUSION

This article has explored how using the principles of Gagne’s instructional events to produce an effective and comprehensive lesson plan for teaching psychomotor skills in small group settings prepared learners with various preferred learning styles to perform procedures competently in the clinical setting.

REFERENCES

11. Schofield S. Lesson Planning. Course material from Centre of Medical Education. Dundee: University of Dundee; 2011.

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