Review Article

Teaching Procedural Skills in Clinical Education Using Gagné's Instructional Design Model

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ABSTRACT

Competence in teaching procedural skills is required for faculty in all clinical specialties of a medical college. There exist several long-standing and widely accepted theories on psychomotor skill acquisition, which favour graduated learning and sequential teaching approach; Gagné's instructional design model is one of them. Gagné's instructional design model is based on the idea that learning is a process that involves the acquisition of knowledge and skills through a series of steps. Teaching procedural skills is crucial in medical education and evidence showed that Gagné's model delineates a sequence of specific instructional events that correlate with crucial conditions of learning, providing a framework that is able to maximally enhance the learning process, improve session flow and ensure that objectives are comprehensively addressed. This review paper aims to see how and to what extent Gagné's instructional design model supports teaching procedural skills to medical students.

Keywords: *Gagné's instructional design model, clinical education, medical education, procedural skills, teaching and learning.*

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INTRODUCTION

In a resource-poor setting like Bangladesh, medical education often suffers from lack of rigorous and appropriate instructional designs;[1,2] however, in recent years situation has fortunately improved, and medical educators now have access to much higher quality medical education research through online resources to guide development of medical curriculum and instructional methods.[2,3]

Competence in teaching procedural skills is required for faculty in all clinical specialties of all medical colleges in Bangladesh. For our involvement in undergraduate medical education, all faculty members are likely be involved in teaching procedures to novice learners at some point, with the goal of having the learner achieve graduated independence and technical competence in different skill sets.[1] Teaching procedural skills to novices is complex because it requires not only teaching new cognitive tasks but motor skills as well. These newly found psychomotor or procedural skills must be retained so that physicians can access them at the bedside of the patients sometimes years after they were initially taught.[4,5] There exist several long-standing and widely accepted theories on psychomotor or procedural skill acquisition, which favour a graduated learning and sequential teaching approach;[6,7] Gagné's instructional design model is one of them.

Gagné's instructional design model is based on the idea that learning is a process that involves the acquisition of knowledge and skills through a series of steps. The conditions of learning, which were first postulated by Gagné in 1965[8] and elaborated upon in his later works done in 1985.[9] Gagné's nine events of instruction is a component of his 'Conditions of Learning Theory' (Fig. 1).

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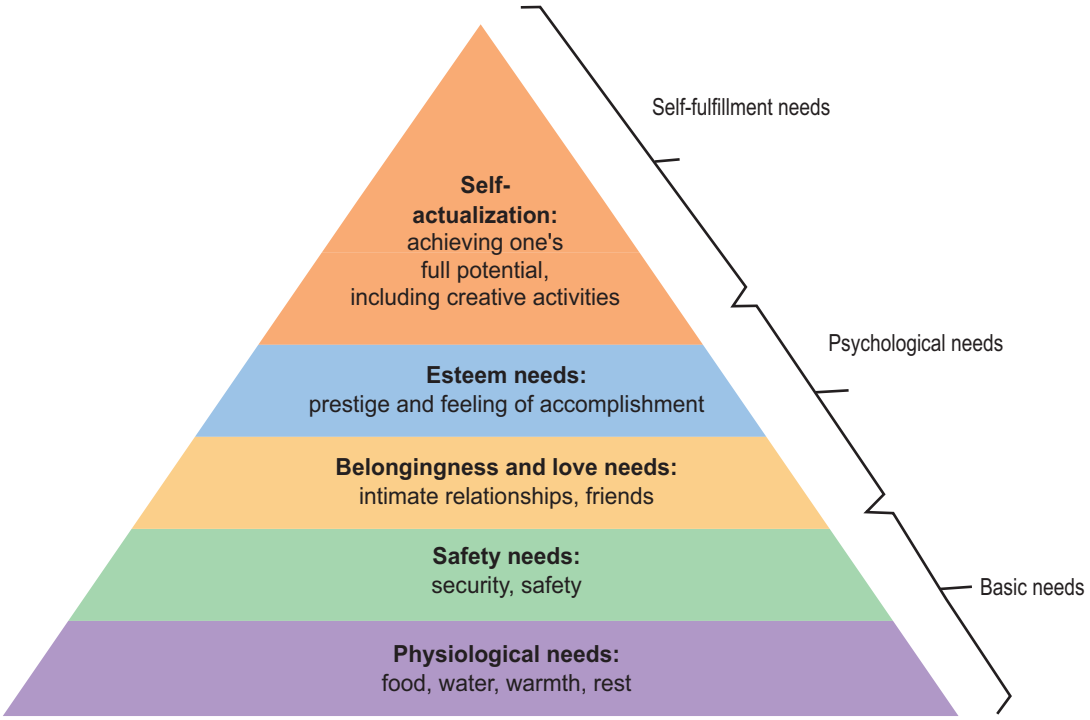

Fig. 1. *Conditions of Learning (Based on Gagné, 1965)*[8]

In this theory, he outlines nine specific steps that instructional designers should use when designing a program of instruction.[9] They are as follows: 1) gain attention: capture the learner's interest and motivate them to engage with the content; 2) inform learners of objectives: clearly state the goals and outcomes of the learning experience; 3) stimulate recall of prior learning: activate the learner's existing knowledge and build upon it. 4) present the content: deliver the information in a clear and organized manner; 5) provide learning guidance: offer support and guidance to help learners navigate the material; 6) elicit performance: encourage learners to practice and apply their knowledge and skills; 7) provide feedback: offer constructive feedback to help learners improve their performance; 8) assess performance: evaluate the learner's progress and mastery of the content; and 9) enhance retention and transfer: help learners transfer their knowledge and skills to real-world situations (Fig. 2).

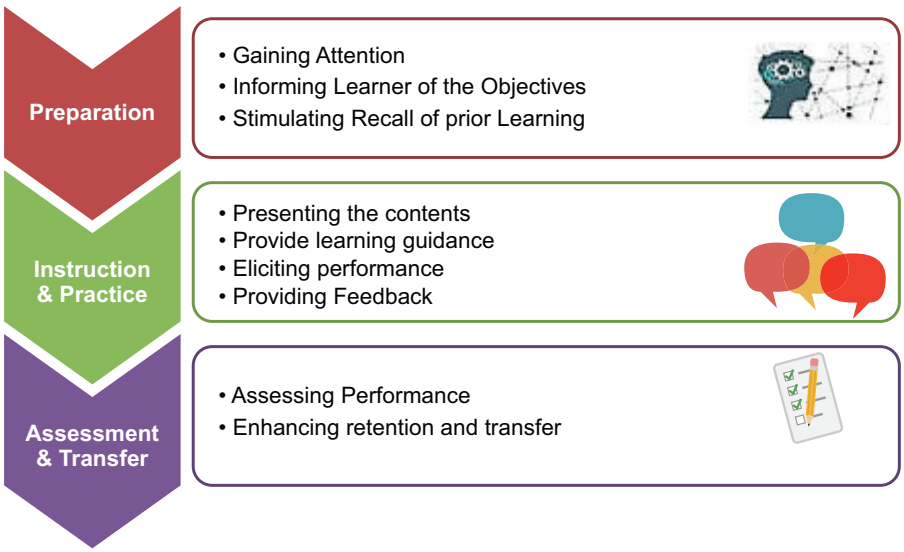

Fig. 2. *Nine Elements of Learning (Based on Gagné, 1985)*[9]

The steps or strategies require the instructional designer to address the possible conditions that would affect the learners' ability to understand and process new and prior knowledge. His theory is based on information processing models that focus on the cognitive events that happen when learners are presented with a stimulus.[9] Gagné's theory is used in the instructional technology field largely because of the theories ability to be adapted for all types of learning environments and learning modalities. Gagné's theory draws from both the behaviorist and cognitivism models of learning.[7,10,11] According to Gagné's theory the five kinds of learned capabilities are: intellectual skills, cognitive strategies, verbal information, attitudes, and motor skills.[9,12]

As medical educators, it is imperative that we use teaching techniques founded on evidence based medical education research as far as possible. Ineffective instruction risks producing poorly performing physicians in an era of increased accountability, with potentially harmful and costly consequences.[13] Teaching procedural skills is crucial in medical education and evidence showed that Gagne's model delineates a sequence of specific instructional events that correlate with crucial conditions of learning, providing a framework that is able to maximally enhance the learning process, improve session flow and ensure objectives are comprehensively addressed.[4,5,7,14,15] Therefore, this paper aims to see how and to what extent Gagné's instructional design model supports teaching procedural skills to medical students.

METHODS

The literature search was conducted using 'Google Scholar' and 'PubMed' and consisted of the search terms – "procedural skills," procedure skills," "procedural skills training," "procedure skills teaching," "clinical skills," "skills training," "undergraduate medical education," and "medical education." References were searched for additional articles. From those articles, we went through the abstracts and searched specifically for the papers that used "Gagné's instructional design model" in teaching "procedural skills." Non-medical articles were not excluded because we did not want to eliminate articles pertaining to coaching or deliberate practice that are pertinent to skills acquisition. We sought additional papers, even books on teaching methodology guidelines, if available. However, non English articles/papers were excluded. After primary sorting and reading the abstracts, only relevant papers were downloaded, and we did try to do an extensive review of those downloaded papers. After meticulous scrutiny, a total of 26 articles were finally selected and utilized to perform this review.

RESULTS

The selected 26 articles were sorted and found diverse in terms of teaching different clinical procedures. However, using Gagné's instructional design model to teach medical procedures, the papers' discussions were on Gagné's theory of instructional design, developing lesson plan, describing learning outcome, constructing, and tailoring the instructional events necessary to achieve this outcome. This model has been used to develop instructional plans to teach a variety of procedural and communication skills, which were also discussed by some of those papers. Conventionally, as we have observed, Gagné's theory of instructional design has five learning outcomes and nine events of instruction.[9,12]

DISCUSSION

Essential to Gagné's ideas of instruction are what he calls "conditions of learning": internal conditions deal with what the learner knows prior to the instruction, external conditions deal with the stimuli that are presented to the learner, e.g., instructions provided by the teacher.[7,8]

Using Gagné's model to teach psychomotor skills, several evidence revealed the same general approach and structure outlined herein which can be applied to multiple clinical skills across specialties. For example, Belfield showed how to teach chest x-ray interpretation,[13] while Buscombe used the example of teaching bone marrow aspiration.[14] The research explored and found that proposed activities, hints and tips, as included in the model, allowed educators to develop engaging lesson plans that systematically address key learning events in an ordered and evidenced manner[7,11,14-24] This model enables educators to design teaching plan with reliable checklists or rating scales to assure competence in the procedure as checklists assure that learning objectives are met and procedures are taught in a stepwise fashion, while rating scales allow for assessment of procedural skills acquisition;[7,11,14-24] however, they are not "as granular as checklists".[5] This framework has provision for positive constructive

feedback and suggestions for improvement to the learners, which ultimately helps them with the opportunities for focused and repetitive practice.[7,11,14-24] The whole process provides a psychologically safe environment for learners.[20,21,23-25]

Gagné's model follows a systematic instructional design process while ensuring flexibility to adjust according to specific situations in training. In fact, this is one of the most widely used instructional design models due to its suitability for online training.[26,27] This can be integrated in simulation based medical teaching as well.[18-20] However, the use of a dedicated clinical skills lab for such sessions allows a more structured and comprehensive teaching plan, and more conducive learning environment compared to that of done in the ward or outpatient department of the hospital or any outpatient clinic.[13,19-21] Gagne's instructional design does not only provide a platform for lecture-based lessons but can also be expanded to accommodate lesson planning for a wide range of skills, such as practical, communication, and interpersonal skills.[20,21,23,26] Another important observation is that this model avoids the common pitfall of teaching procedures as isolated entities, with procedural understanding instead embedded in real-life application and relevance, which is very essential for clinical education.[7,15,18] Moreover, evidence suggests that students 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.[7,15,25] Thereby, it creates opportunities for co-creation of learning objectives, as well as assessment procedure/rubrics.[7,18,26] Besides, in this model of teaching, the transfer of knowledge constitutes applying their skills in a clinical setting, while initially being supervised. The session can be closed by reviewing the key points, answering the questions, and asking for learners' feedback.[7,22,26] This type of teaching strategy has great value to the trainees, it provided them with the opportunity to interact with other participants and learning from their previous experiences.[14-25] Overall, it enhances aids grater learner participation and collaboration.[15,23]

Gagné's instructional design model is a valuable tool for teaching procedural skills in clinical education. By incorporating the nine events of instruction into lesson planning and delivery, educators can create effective and engaging learning experiences that promote skill acquisition and mastery.[7,15,16,26] For students, they move their abilities into clinical practices when they are out for their clinical practicum or residency training as well as further individual practice.[13,19] However, in designing a session based on Gagne's model, several factors need to be considered. Including the nature of objectives, setting, time, available resources, institutional constraints, content, number of learners, their characteristics and their preferences.[7,22,26-31] For example, many studies applied this strategy and support its suitability only in small group teaching.[7,15,19,22,23] Table-I shows how Gagné's events of instruction and internal cognitive processes work. However, the events do not always occur in this exact order[12,26,28] and not all events must be present for learning to occur, as their purpose is to stimulate internal cognitive processes, not replace them.[12,26,28-30]

Table-I: *Gagné's events of instruction and internal cognitive processes*[28]

Instructional Event	Cognitive Process
1. Gain attention	Reception of pattern of neural impulses
2. Explain objectives	Activating the process of executive control
3. Stimulate recall	Retrieval of prior learning to working memory
4. Present content	Emphasizing features for selective perception
5. Provide guidance	Semantic encoding; cues for retrieval
6. Elicit performance	Activating response organization
7. Provide feedback	Establishing reinforcement
8. Assess performance	Activating retrieval; making reinforcement possible
9. Enhance retention	Providing cues and strategies for retrieval

In practice, one of the challenges identified is that there is no evidence of applying this model in large group teaching.[28-31] Small group teaching may not be feasible where there are fewer qualified faculty staff able to teach following this specialized model.[17,26,28-31] Another challenge is experimenting such model in low-resource settings like Bangladesh, which is often difficult in terms of money and manpower. The cost of consumables and related equipment for such training and practice may create a huge financial burden for many medical colleges in the country.[3] Besides, our medical teachers do not have proper training, they also lack time[3,30] and proper institutional guidelines[3,31] and most of them stick to traditional 'teacher-centric' instructional methods.[31]

CONCLUSION

Gagné's model is based on how humans process information; his principles refer to actions from both teachers and learners during the teaching process. In Gagné's theory of instructional design, the developer of the lesson plan must first pin down the type of outcome to be achieved; only after that should instructional events be tailored to achieve this outcome. Gagné's instructional design model can be effectively applied in clinical education to teach procedural skills to students. By following the nine events of instruction, educators can create engaging and interactive learning experiences that promote skill acquisition as well as retention. Besides, when needed, for online learning, those nine events of instruction can also be operationalized in both synchronous and asynchronously in medical teaching and learning.

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