

KNOWING HOW TO TEACH KNOW-HOW: IMPARTING PROCEDURAL KNOWLEDGE

Teachers in the Collège Montmorency's Physical Rehabilitation (TRP) and Orthotic and Prosthetic Devices (TOP) programs have been testing a process aimed at improving the quality of procedural-knowledge instruction. This approach to teaching practical knowledge resulted in a different view of the teacher's role and promoted the development of a collaborative method involving, not only teachers themselves, but also lab technicians. It has also helped optimize the time allotted to labs, empower students to a greater extent, and, more particularly, improve their grasp of procedural knowledge. The experience has also given rise to a more integrated vision of the programs as concerns course development.

CONTEXT

Over the past few years, many of the faculty in both the above-mentioned programs have been taking advanced courses in college teaching, and quickly shown an interest in exploring and experimenting with new instructional methods. Accordingly, it has become increasingly easy for them to diversify activities in their theory courses and make the learning of declarative knowledge more effective.

As a result, we began to look for a way to improve lab instruction. We wondered if we could find a more efficient way to teach procedural knowledge other than via simple demonstration. Since our teaching contexts were similar, a partnership between our departments developed naturally, and allowed us to work together toward that goal.

The College's Nursing department had, in fact, just begun to explore the teaching and learning of procedural knowledge. Accordingly, we examined the approach developed by two college-network Nursing instructors—Raymonde Bourassa and Marie Fernandes (2007), from the Montmorency and Bois-de-Boulogne CÉGEPs, respectively.

Their efforts were based primarily on the works of Barbeau, Montini, and Roy, who, in their 1997 monogram, described the main steps involved in teaching procedural knowledge—i.e., proceduralization, shaping, and automaticity.

The basics of that approach are as follows:

Practical knowledge must be internalized in order to ensure a certain degree of mastery and ease of use. This takes time. Acquiring procedural knowledge requires a knowledge of the general procedure to be followed, an adaptation of that procedure in a given context, and, especially, repeated exercises allowing it to be retained and used automatically (1997, 409).

After reading the report Raymonde Bourassa (2009) drafted upon completing her project, we were able to establish close parallels between the problems experienced in Nursing and those we were having in our respective programs.

PROBLEMS ENCOUNTERED

Below are the principal problems we were hoping to solve.

— Lack of time for teaching procedural knowledge

Like students, teachers complained of a lack of time in the lab—and rightly so! They were using a large part of their practical-course instruction time to review theoretical concepts before proceeding with demonstrations, which reduced the number of periods reserved for procedural-knowledge acquisition. Students, for their part, barely had time to familiarize themselves with one procedure before a new demonstration was conducted, and so on and so forth. To help them overcome the gaps in their learning, teachers had to add extra preparation and correction time, as well as supervised exercises, to their regular schedules.

— Lack of student empowerment as concerns learning

Too many students were arriving at the lab without being adequately prepared, or even without the necessary equipment. At the beginning of each lab, teachers would therefore have to re-explain everything, review the concepts, and describe what was to be learned. Only then could they proceed with the matter at hand.

When implementing procedures after the demonstration, many students would ask to be guided through each step, by either the teacher or the lab technician. Without the necessary tools, they had to rely primarily on their memory to implement the demonstrated steps in sequence. Moreover, in order to gauge their performance, they would rely on the instructor's or lab technician's assessment. While initially, such cues provided feedback, essential to learning (but also required teachers



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and technicians to spend much more time watching students experiment!), for some students, this tactic eventually constituted an obstacle to the development of their ability to assess their own performance.

— **Lack of standardization in procedural-knowledge instruction**

The learning of procedural knowledge involves students, teachers, and lab technicians alike in practical assignments—all of whom, from their respective standpoints, stressed the lack of standardization in instruction, as well as in the implementation of procedures. The number of diverse practices was creating confusion, making the teaching and learning of procedural knowledge more difficult.

— **Lack of procedural integration**

The problems described above manifested themselves intensely as exams approached. Teachers noticed their students had not mastered enough of the procedures taught; hence, the increased number of supervised exercises and extra preparation and coaching time required. Although the great majority of students managed to reproduce the techniques involved during exams, learning seemed rather perfunctory; unfortunately, there seemed to be little integration or transfer in subsequent courses. A number of procedures, for example, had to be reviewed over the following semester.

▮ **OBJECTIVES IN SOLVING THE PROBLEMS ENCOUNTERED**

To solve those problems, we submitted to the College a plan for implementing a structured approach aimed at improving the teaching of procedural knowledge.

This plan was based on the following objectives:

- Make the most of lab periods.
- Empower students as regards their learning.
- Develop a collaborative teaching method involving faculty and lab technicians.
- Facilitate the integration and transfer of the procedures.

▮ **PROPOSED APPROACH**

Our approach, adapted from Bourassa and Fernandes, involves four main steps: prepare, apply, practise, and integrate (illustrated in a poster found in all labs in our departments¹). Below is a description of each step.

PREPARE

Students are asked, *before* the lab, to familiarize themselves with the content that will be explored *during* the lab. To aid in this process, teachers have students prepare by reading material in advance, viewing short videos, conducting information searches, familiarizing themselves with terms and concepts, and asking questions related to basic theoretical aspects (and even the procedure *per se*). A “procedure” is primarily a list of the steps to be taken in order to implement know-how. It is important here to distinguish between procedure and application. The same procedure can be used with different applications; for example, the procedure involved in casting orthotics is the same for the upper and lower limbs.

Preparing students is vital. Whether for a theory course, a lab, a workshop, or even an internship, students must know what is expected of them, what needs to be reviewed, and what will be learned, in order to optimize their participation. Teachers can provide guidance in this regard. As it is up to them to ensure students are properly prepared, it is vital that the abovementioned preliminary work be useful and relevant, so students see the benefits and are encouraged to take the same tack course after course.

This step is somewhat akin to flipped learning, in which lectures are eliminated and class time is used for assignments, where homework consists in reading up on theory and exercises are done in class (Girard).² With our approach, however, preparation is often limited to the essentials to be reviewed, and does not include all concepts to be mastered before they

¹ This poster is available at [www.cmontmorency.qc.ca/images/liens/comment-faire.pdf].

² For more information on flipped learning, go to the 2013 *Pédagogie collégiale* article by Dave Bélanger at [aqpc.qc.ca/sites/default/files/revue/Be%25C%2581langer-Vol_27-1.pdf].



are applied in the lab. Our approach, in this sense, is not a strict flipped-learning viewpoint, which is geared towards the use of technology.

APPLY

Step two is carried out *during* the lab. Teachers first summarize the preparation step in order to allow students to transfer that knowledge to what they will be learning next. By affirming the importance of the work students did before the lab, teachers help empower them in the knowledge-appropriation process.

Teachers then proceed with an *initial demonstration*. Speaking slowly and clearly, they describe each step of the procedure, with no explanations or additions. They then give students a few minutes to commit what they have just observed to memory. The latter are asked to explain the basis of the procedure demonstrated, identify key words, or produce a graphic representation. Carrying out one of these exercises is important, as it promotes internalization of new procedural knowledge.

Next, teachers conduct a *second demonstration* (this may also be done by a class volunteer). At this stage, and at this stage only, do they detail the most common errors, pitfalls to be avoided, and important aspects to be considered; students can take this vital information to correct, complete, or clarify the notes taken previously. In this way, the procedure is constructed.

These last two steps correspond to *proceduralization*, which Barbeau, Montini, and Roy describe as the phase during which students must identify and arrange all operations to be carried out in order to complete the task (1997, 282).

PRACTISE

Students are encouraged to *repeat* the procedure after the demonstrations. To assist with the initial application, the written procedure should be provided; it can also be incorporated into a checklist (see [Figure 1](#)). This tool helps students ensure they have followed the procedure correctly, carrying out each step in sequence; they can refer to it in class or during individual exercises. The checklist should be used at the appropriate time when the procedure is being learned, not every time it is applied; otherwise, students will check off each box automatically, without reaping the inherent benefits.

Once students have mastered the steps of the procedure, they must *perfect* it. Teachers must specify their expectations regarding performance quality by discussing the criteria for

each step. The criterion-reference self-assessment form (see [Figure 2](#)) helps students determine if the steps have been carried out in accordance with established criteria; thus equipped, they are able to critique their performance in order to make any necessary changes, which considerably promotes learning. Our experience showed that a number of teachers already had a weighted version of this form, and were using it during summative evaluations (they are now asked to distribute it during labs). Lastly, to optimize their ease with the procedure and speed of execution, students are encouraged to arrange practice sessions with their peers outside of class. With the help of the criteria-referenced form, they are able to assess and correct one another, thereby better cementing their learning.

As it is up to (teachers) to ensure students are properly prepared, it is vital that the abovementioned preliminary work be useful and relevant, so students see the benefits and are encouraged to take the same tack course after course.

For Barbeau *et al.*, this step corresponds both to *shaping*, the stage at which students must, after an initial attempt, modify their approach, and to *automaticity*, which consists in carrying out the procedure several times and internalizing it, so it becomes automatic (1997, 282).

INTEGRATE

Lastly, teachers help students use their new procedural knowledge in new situations (integrative exercises, simulations, case histories) or contexts (clinical settings and internship) that promote the *transfer* of learning. In so doing, we hope to facilitate the learning of conditional knowledge, which Barbeau, Montini, and Roy define as practical, context-based knowledge (1997, 285).

IMPLEMENTING THE PROJECT: CHANGES TO OUR PRACTICES

While the proposed approach was consistent with several techniques already used by teachers from both programs (homework done before class, initial demonstrations of procedures, memorization of procedures with the help of numerous reminders, corrections made during the application phase, encouragement to practice regularly in order to improve), it also made it possible to integrate those techniques into a much better structured and thought-out method department wide.



FIGURE 1

SAMPLE CHECKLIST (EXCERPT)

STEPS INVOLVED IN GONIOMETRY	TAKEN	NON TAKEN	COMMENTS
Preliminary steps <ul style="list-style-type: none"> • Planning: articulation, movement, axis/plane, contraindications, order of maneuvers, premises and equipment, etc. • Contact: introduction, use of goniometer, instructions on pain. 			
1. Positioning <ul style="list-style-type: none"> • Place patient in recommended testing position, if possible: alignment, comfort, allow for full range of motion. • Adopt an ergonomic work posture at all times. 			
2. Instructions and Visual Estimation <ul style="list-style-type: none"> • Explain movement in terms patient can understand (demonstrating if required). • Stabilize the proximal segment (if necessary). • Correct for compensation. • Estimate measurement. • If applicable, remind patient of the instructions on pain, reassure him or her, etc. 			
3. Goniometer in Initial Position <ul style="list-style-type: none"> • Remind the patient about use of goniometer, need for palpation, etc. • Palpate anatomical landmarks. • Align pivot on landmark and look for zero-degree mark on goniometer. • If keeping goniometer in place during movement, ensure instrument arms are parallel. 			
4. ...			
Most frequent errors			

To facilitate implementation of our approach in all labs of both programs, we suggested it be done gradually over six sessions and spearheaded by two faculty members from each department. After identifying the main procedural knowledge to be imparted, these individuals assisted their colleagues in developing procedures and producing tools for each lab. To provide a framework for this process and to set out drafting guidelines, we suggested the criteria we felt should characterize proper procedure (which should, for example, be simple, applicable, reproducible, and consensual).

- A procedure is applicable when it is easy to conduct, complete, redo, etc.
- A procedure reproducible when it is applicable in different conditions and situations.
- A procedure is consensual when it is the subject of an agreement among several people, when most teachers ratify it with a view to establishing best practices.

- A procedure is simple when it is easy to understand, within everyone's grasp, accessible, clear, coherent, and so on.

Given that the approach adopted necessitated the active participation of students, the latter were introduced to it in the first semester of each program, during a meeting lasting some 90 minutes set up by the two faculty members from each concerned department.



FIGURE 2

SAMPLE CRITERIA-REFERENCED SELF-ASSESSMENT FORM (EXCERPT)

SELF-ASSESSMENT FORM FOR FINAL EXAM					
OBJECTIVE	CRITERION	DONE with ease	DONE with difficulty	NOT DONE	COMMENTS (aspects to be corrected)
Establish a context favorable to providing care.	Preparations for equipment and premises have been efficient .				
	The relevant contraindications have been verified before treatment.				
	Correct, precise instructions and information (safety rules, sensations to be expected, rest or activity, etc.) have been supplied before and after treatment.				
	The pertinent sensitivity tests have been correctly performed.				
	The skin has been carefully examined before and after treatment.				
	Safety measures have been thoroughly implemented throughout treatment (gel, cleaning of skin, timer, wire connections, proper electrode contact, etc.).				
	The patient's comfort and privacy have been ensured.				
Explain the principles for using electrotherapy appliances.	Accurate, specific explanations on treatment goals have been given to the patient and the teacher.				
	The appliance chosen is consistent with treatment goals.				
...	...				

► **OUTCOMES OF PROJECT IMPLEMENTATION**

From the first semester of implementation on, we received informal but significant testimonials from teachers and students on the positive effects of the approach; these benefits were observed throughout the six terms of the experiment. They were also confirmed by participant evaluations (satisfaction questionnaires and focus groups). The outcomes helped us determine the benefits of the approach, as well as take the necessary corrective measures. Below are a few of those outcomes, as they apply to our original objectives.

— **Objective 1**
Make the most of lab periods

With better prepared students, better targeted content, and more structured teaching methods, lab and workshop periods were optimized with respect to procedural-knowledge

learning. The need to review theory during labs having been reduced, more time was available for implementing methods aimed at learning actual procedures. Some teachers even said they had time to bring in new activities.

— **Objective 2**
Empower students as regards their learning

The approach allowed us to more systematically establish preparatory activities. Students from both programs came to labs with a better knowledge of the concepts essential to learning procedures, and were more aware of what was expected of them. During the labs, they asked more specific—and, even more importantly, more relevant—questions, a fact that testified to a higher level of preparation. Teachers could then provide more in-depth explanations and demonstrate more of their professional expertise when answering students' questions.



Knowing what would be explored, students came to the lab with the necessary materials (reference books, course notes, exercise books, and completed homework), which obviously enhanced their participation and independence.

In addition to making written procedures available, teachers developed a number of other tools (checklists and criteria-referenced self-assessment forms), the use of which helped students develop an ability to critique their own performance, identify their own mistakes, and determine which aspects needed improvement. By enhancing their capacity to regulate their own behaviour, students were able to work more spontaneously with their peers, as they did not have to rely nearly as much on teachers or lab technicians to correct them. As, over the three years of the experiment, teachers did not actually have to organize many extra supervised exercises, it may be concluded that this approach promoted the development of the metacognitive strategies essential to students taking ownership of the learning process.

In the Physical Rehabilitation program, students were asked to keep all procedures taught in a portfolio they had created from session to semester. Once they were doing their practicum, they referred to that portfolio often in order to confirm their procedural knowledge. Teachers and internship supervisors alike stressed the usefulness of this tool, as it provides instant access to a description of the main procedures taught in various courses.

— **Objective 3**
Develop a collaborative teaching method involving faculty and lab technicians

Teachers who were giving the same course to different classes indicated that the project had encouraged the development of a collaborative and more consistent teaching and learning process. Sharing tools helped standardize what was taught, thereby ensuring greater equity as concerns expected student performance. Lab technicians also stressed that using this approach had facilitated their job and enhanced their role. Because they too were equipped with new tools, they were able to more effectively provide students with guidance and become valuable resources able to meet students' needs in accordance with expectations that had been properly identified by teachers.

Moreover, this better structured and thought-out approach made it possible to target the procedures to be taught with greater precision, and, more particularly, identify in which courses they should be learned. Faculty now refer more to the content of other courses, in order to consolidate learning

more effectively by relying on prior learning. Lab preparations are associated with concepts explored in previous courses (anatomy or pathology, for example) before the procedural knowledge related to manufacturing (of orthotic or prosthetic devices), treatment, or rehabilitation is applied; they may also involve a review of a procedure that results in a student being able to apply a new one. Moreover, teachers work together more to develop procedures that will be used in subsequent courses, thereby facilitating the learning targeted by the approach.

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— **Objective 4**
Facilitate the integration and transfer of procedures

At the conclusion of the experiment, the teachers noticed that they no longer had to systematically review what had been learned in previous semester; they actually noticed a higher degree of mastery of the procedures taught in earlier courses. Today, instead of taking time for formal reviews, teachers have students do preparatory work that involves the core concepts to be integrated into their new procedural knowledge. Although we cannot, as yet, determine the quality of that integration, there have been positive effects on the quality of instruction.

Faculty who experimented with the approach modified their role from being “knowledge transmitters” to “guides in the learning process”. This new method is more consistent with active learning; teachers act, not only as content experts, but also as facilitators, answering fewer questions and asking more, and empowering students rather than correcting their mistakes. In so doing, they stimulate and encourage their charges, promoting self-assessment and peer evaluation. This truly reflects an evolution from a teaching to a learning paradigm.

► **CONCLUSION**

Appropriate for use department wide or, on a smaller scale, in a single class, the approach outlined above is not revolutionary; however, it does represent a significant development in teaching practices, and is the result of deliberations on the different steps of the learning process and the action that should be taken to facilitate each one of them.



Much remains to be done to optimize the approach implementation: several procedures need more work, being too complex or overly detailed; others involve “one-time-only” applications rather than reproducible procedures. By way of illustration, although many teachers are still combining the checklist with the criteria-referenced self-assessment form, this actually causes students to work on the quality of their performance even before mastering the procedure sequence.

Most teachers in our two programs, even though the approach still needs fine tuning, feel they would never go back to their old ways. The structure provided by the approach facilitates course and class organization, as concerns both content and the teaching methods used. Teachers are also convinced of the positive influence the approach has had on teaching and learning quality. Several of them hope to develop, in conjunction with their colleagues, certain common procedures applicable to many courses (e.g., with respect to pre-treatment patient preparation or informed consent³). Given its major advantages for our students, the procedural-knowledge teaching approach has been integrated into the recent revision of both programs.

As interest in information on this approach has been so strongly expressed, an interactive Website should be developed to serve as a reference for the entire college community, providing information on the approach as well as examples of preparatory activities and support tools. We will be publicizing this address as soon as it becomes available. ◀

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³ According to the federal Translation Bureau's TERMIUM Plus Website [btb.termiumplus.gc.ca/tpv2alpha/alpha-eng.html?lang=eng&i=&index=frt&__index=frt&srchtxt=consentement+eclairé&comencsrch.x=0&comencsrch.y=0], informed consent is “the legal and ethical obligation not to perform any significant medical procedure until a competent patient has been informed of the nature and risks of the procedure and the alternatives to it, as well as of the prognosis if the procedure is not done.”

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