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Application of Pedagogical Perspectives in the Teaching and Training of New Cataract Surgeons—A Literature-Based Essay

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ABSTRACT

Cataract is the most common cause of visual impairment that can be effectively treated by surgery and cataract surgery is the most commonly performed surgical procedure in the world. With modern cataract operation techniques, patients expect excellent results. Teaching and training of new surgeons involve both pedagogical and ethical challenges for teachers and trainees, and also may pose a potential risk to patients. This literature-based essay aims to describe how behavioristic, cognitive and conceptual learning perspectives can be recognized during the trainee surgeon's progress. It also describes how teacher-pupil relationships may vary during the training process. Finally it presents the concept of situational tutorship, where the teacher adapts to the stages that the trainee passes through with increasing experience. Teaching and trainee surgeons who are aware of pedagogical concepts such as teacher-pupil relationships and tutoring strategies may use this knowledge to optimize the learning process. Further research is needed to clarify how using this knowledge may affect the training of new cataract surgeons.

Keywords: Cataract Surgery; Teaching; Training; Learning

1. Introduction

Modern cataract surgery is carried out through a microscope with 7 - 10× magnification. Dexterity is necessary as the surgeon's hands and feet are constantly active during surgery (**Figure 1**).

Developments in surgical technology and techniques have improved outcomes in terms of quality of vision and life, and increased safety has led to widened indications and more operations performed [1]. Hence, in developed societies patients expect their cataract operation to be painless and quick, with excellent outcome after a short period of recovery. Patients and health care systems also demand good accessibility. Surgeons therefore need to be trained in order to meet continuously growing demands and expectations. However, when an operation is performed by a trainee surgeon or a less experienced independent surgeon, there is a greater risk of surgical complications [2]. Complex ethical issues thus arise when teaching new surgeons, as Bernstein & Knifed point out regarding neurosurgery [3]. These issues are further emphasized by the fact that cataract surgery in almost 100% of cases is carried out nowadays under local anesthesia with light or no sedation, allowing patients to be aware of surrounding activities and conversations during their operation. An ethical dilemma arises when, in order to make cataract surgery accessible to future (and larger numbers of) patients, and with present methods for education of new surgeons, certain patients will undergo surgery under conditions that in many ways must be considered to be "high-risk environments". For example, when the operation is performed by a surgeon with limited or no experience, assisted by a teaching surgeon who will try to communicate this to the trainee surgeon and staff in a way that causes as little alarm as possible is judged to be necessary. Several authors have discussed how to optimize training of surgeons in order to address these ethical issues and decrease the risk of complications [4-9].

As Henderson and Ali summarize, the trainees must master cognitive knowledge at the same time as they need to develop a spatial familiarity with the three-dimensional surgical anatomy of the eye, coupled with sufficient technical dexterity to execute surgical maneuvers within a small space limited by sensitive structures

Figure 1. Surgeon's position during modern cataract surgery is shown with one instrument in each hand, manipulating the intraocular tissues through incisions < 1 mm - 2.5 mm (inset top left). Left foot pedal controls the microscope zoom, focus and position in three dimensions; right foot pedal controls the phacoemulsification machine.

[7]. Most literature on training cataract surgeons deals with the structural framework of training. Tests, surgical training facilities such as simulators and wet labs, and methods such as the delivery of graded responsibility and modular surgery have been described [4,5,7]. The pedagogical perspectives that can be applied by the teaching surgeon during the various phases are not discussed to the same extent.

The aim of this paper is to problematize the process of education and training of new surgeons, and by means of a literature search explore how awareness of different learning perspectives, teacher-student relationship models, and possible pedagogical approaches can be of value in this process.

2. Materials and Methods

Apart from own experience, personal communication and basic literature and papers within the field of pedagogical science and learning this essay is based upon a literature search performed using the National Library of Medicine PubMed (www.pubmed.gov) and the Education Resources Information Center (ERIC) databases. Search terms were "cataract surgery, microsurgery, surgery, learning, teaching, training, learning perspectives". Search results were reviewed and articles not relevant to the topic "surgical teaching" were excluded.

3. Learning Perspectives and Cataract Surgery Training

Different learning perspectives can readily be identified within the process of training cataract surgeons. The behavioristic perspective is evident as regards the surgeon's ability to memorize and perform a predefined set of surgical maneuvers, which are repeated under supervision and refined by immediate negative and positive feedback from the supervisor [10]. Internal feedback is also important: It is not difficult to imagine the frustration, disappointment or even dread that the trainee surgeon experiences when realizing—either by own observation or information from the teaching surgeon—that a complication is imminent or has occurred. On the other hand, a surgical step successfully completed evokes a positive feeling. A cognitive perspective is also important. For example, the inner process of reflecting upon how surgical maneuvering must adjust to the anatomical relations in each specific case enables the surgeon, as experience increases during training, to anticipate and prevent complications [11]. During later stages of training, when the trainee surgeon operates on conscious patients and interacts with them as part of a surgical team, the contextual learning perspective is evident as well [12]. A schematic outline of the various steps in a training program for cataract surgery is shown in **Table 1**.

4. Teacher-Student Relationships and Cataract Surgery Training

Selecting who is to enter the training program (**Table 1**) is sometimes the responsibility of the teaching surgeon, but trainee surgeons can also be chosen by clinic executives upon request (or without it) by an individual wishing to be trained as a surgeon. In some—but not all—countries, training in cataract surgery is a part of a general curriculum for specialist training. The risk of nepotism should not be overlooked if the teaching surgeon has influence on the selection. On the other hand, Gagliardi *et al.* found that an existing relationship appeared to be a key enabler of mentorship [13]. Selection mechanisms where the teaching surgeon has less influence might increase the risk of enrolling less determined or even less suitable candidates. When researching relationships between students producing scientific texts and their supervisors, Dysthe identified three basic models [14]. 1) In the teaching model, a

Table 1. Contents of the various stages of a cataract surgeon's training program.

Stage of training program	Content
Evaluation/Selection of trainees	
Acquisition of theoretical knowledge	Clinical knowledge Complicating factors Patient selection criteria Surgical techniques Handling of equipment and instruments
Motor skill training without patient presence	"Dry" use of equipment (microscope, instruments, and machinery) Wet lab training Simulator training
Clinical training with patient presence	Observation of tutor performing surgery Step-wise execution of different surgical elements Selection of patients Complete surgery performed by trainee, tutor present Complete surgery performed by trainee, tutor present only when requested by trainee
Independent surgery	Stepwise increasing numbers of operations performed per working period Stepwise increasing expected degree of surgical difficulty Continuing but decreasing need for consultation in difficult situations

traditional teacher-pupil relationship with obvious hierarchical construction, the teacher has knowledge of the requirements for a successful project and the methods to attain the set goal, and conveys this knowledge to the student in a one-way communication. Being instrumental in the selection process puts the teaching surgeon in a higher hierarchical position and can lead to accentuation of the teacher-pupil relationship, at least at the beginning of the training program. 2) In the partnership model, tutor and student approach their task (e.g. training of the student in general, or a specific surgical case) as a joint project. 3) The apprenticeship model has been well-known in the surgical field since William Halsted refined the concept of how surgeons are trained through first observing how the tutor performs a task and then performing the task in the presence of the supervising tutor [15]. As in the teaching model, a strict hierarchy between the tutor and the trainee surgeon is obvious in the training situation, although in other aspects there may be a collegial, peer relationship. In the medical field, the Halstedian approach is sometimes referred to as "see one, do one, teach one". Not only does this expression mirror the fact that resource limitations force teaching to be done within a limited time frame, but it also reflects the accepted view that learning is achieved on a deeper level when performing a task instead of observing, and even more so when the student in turn teaches others how to perform the task.

The complex effect of taking a role as supervisor *vis-à-vis* a colleague or a peer (who in some aspects or fields may have a superior position) has been discussed by Denicolo [16]. As the specific relations above, as outlined by Dysthe, can be rather different from other relations and context between training and teaching surgeon, power and responsibilities need to be balanced properly with regard to the surgical training situation. One of Denicolo's informants points out the potential difficulty in delivering critical feedback accurately to a peer.

The influence on the learning process exerted by the roles and relationships between teaching and trainee surgeons is not a common topic in literature. Memon & Memon made a distinction between the roles of trainer and mentor, respectively, and identified a lack of formal mentorship programs and learner-support in surgical training [17]. A mentor should not only act as a surgical teacher, but according to Kay and Hinds also be "prepared to think about the broader aspects of people development and the factors that influence them in their daily work and choice of careers" [18]. Gagliardi *et al*. [13] investigated how mentorship format, delivery, and content influenced participation in and the impact of two programs for training specific surgical measures for breast cancer and rectal cancer. Their qualitative approach identified barriers, such as scheduling and financing, but also found that a key enabler was a pre-existing relationship between mentor and mentee.

Learning perspectives and tutor-trainee relationship change and overlap as the trainee surgeon progresses through the different phases towards independence in surgery, as outlined in **Table 1**. These changes can be instant, e.g. due to how an operation is progressing, or more long-term as the trainee acquires deeper knowledge and develops increased professional independence. It is important to realize that these changes are not a one-way continuous development, but instead there is commonly a mix, or a back-and-forth movement, between different perspectives and relationships. The teaching surgeon needs to be aware of when the trainee surgeon's situation changes, and adapt the pedagogical framework accordingly in order to optimize the learning. The next paragraph discusses how various perspectives come into play in different phases and situations during the training program.

Initially the teacher-pupil relationship as described by

Dysthe is readily recognized, especially if the teaching surgeon is involved in the selection of new trainees [14]. This relationship can easily continue into the next phase, the acquisition of theoretical knowledge, when the teaching surgeon gives advice about suitable sources of knowledge—books, clinical guidelines and preferred practice pattern documents, user manuals, web-based sources, or courses. Although strategies and protocols for assessing that the trainee surgeon attains the learning objectives of this second phase have been described, systematic approaches for this purpose are not generally implemented [5]. Instead, the training and teaching surgeon may commonly come to an agreement about when the learning goals have been achieved. This is also applicable to the third phase, when the trainee surgeon practices technical skills without patients present. Depending on the trainee surgeon's progress, the relationship with the teaching surgeon may take the form of partnership but a teaching model may also be necessary depending on how much guidance the trainee surgeon needs during these earlier phases. During the fourth phase, the apprenticeship model for supervising comes into play, as the trainee surgeon first observes how the teaching surgeon performs the different parts of the operation, and with time progressively applies acquired theoretical and practical knowledge by performing increasingly complete, complex and competent surgical maneuvers on patients' eyes [14].

5. Merging of Motor Skills Training and Contextual Learning

As the surgical training program progresses (**Table 1**), the teaching surgeon's role becomes increasingly important for the final result. When, in the fourth phase, the surgical maneuvers are executed by the trainee surgeon on the eyes of real patients, the teacher needs to be alert and clear when instructing or correcting the trainee. The patient should be informed of the progress of the surgery without being worried by the teacher-trainee communication. A common approach is modular training, where the trainee surgeon in the first cases only performs the simpler steps while the teacher carries out the more complicated parts [4]. As the trainee becomes comfortable with the easier steps, the more difficult parts are successively introduced. Here it is easy to recognize the three major stages of the motor skill theory suggested by Fitts *et al.*, with an initial cognitive phase, where the trainee surgeon reads, listens, watches images, video recordings, and live surgery and forms a mental picture of the performance of the procedure before starting to execute under close supervision—with more or less difficulty—more and more of the full procedure [19]. With practice and feedback from the supervisor the trainee surgeon enters the second stage of the motor skill theory, where the discrete components of the procedure are connected into a smooth chain of surgical events that constitutes the complete operation, with fewer and fewer interruptions. In the autonomous third phase, the surgery is performed more and more automatically without the need for the surgeon to consciously focus on every movement in detail. The motor skills increase by repeating movements and evaluating their outcomes according to Schmidt's schema theory of discrete motor skill learning, in which specific muscle commands aimed to produce a specified response from a defined starting point give sensory consequences (in cataract surgery mainly through visual and, to some extent, proprioceptive feedback), and a response outcome that is recognized and compared with the intended response [20]. In this process, structured feedback from the supervisor has been found to be important [21]. This should be kept in mind when implementing virtual reality methods for surgical training of motor skills, as has been suggested in the field of cataract surgery as well as other surgical specialities [22,23]. As mentioned earlier, structured forms for staging the training cataract surgeon's technical skills have been described [5]. Such forms do not appear to be commonly implemented among Swedish teaching cataract surgeons (personal communication). When the surgical skills acquired by the trainee surgeon during the first three training phases (**Table 1**) are to be applied on a real patient, a whole new set of contextual capabilities and skills will be necessary. The trainee surgeon must focus not only on the specific surgical maneuvers, but also monitor and respond adequately to input from the patient as well as the teaching surgeon and operation room staff (**Figure 2**). The teaching surgeon must not only assess the surgical movements and their outcomes but also pay attention to the contextual learning perspective. Care must be taken to provide feedback and information in a manner that does not make the patient worried. A British teaching cataract surgeon anecdotally instructed a trainee surgeon to immediately stop the surgery at the moment the teacher uttered the word "Excellent!" Coded messages, or silent communication with signs, are probably commonly used by teaching surgeons with the aim to minimize untoward anxiety and tension in the patient. The learning process is inhibited if the tension level of the trainee surgeon increases too much so also from a learning perspective it is important that the teaching surgeon's feedback be conveyed in a constructive, calm, and neutral manner [24].

6. Adapting to Stages and Situations as the Trainee Surgeon Develops

After stating the importance of effective mentoring in the development of surgeons at various levels, Memon & Memon highlighted the absence of true structure and

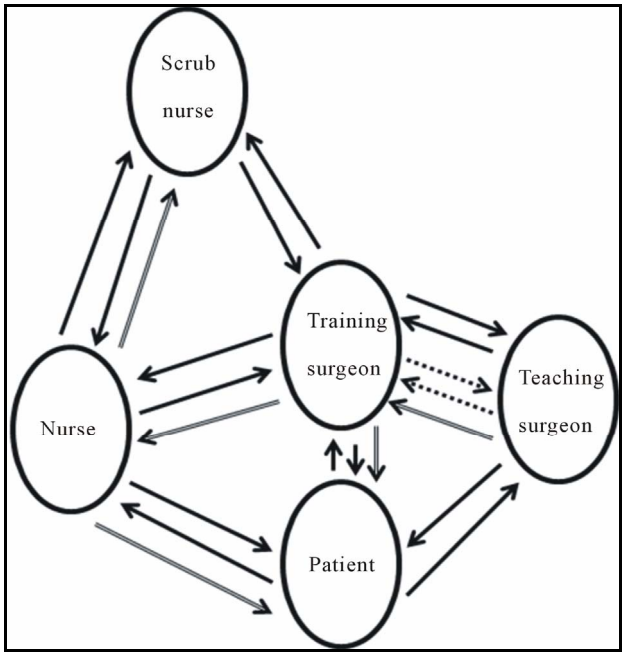

Figure 2. Schematic drawing of the contextual situation in the operation room, at the stage where trainee surgeon is performing the operation with teaching surgeon present. Assistant nurse, trainee surgeon and teaching surgeon are sterile. Scrub nurse is not sterile and may leave/enter the room upon request or stay during the whole procedure. Patient is awake and aware. Black single-lined arrows denote communication with information and instructions, double-lined arrows denote orders. Continuous arrows indicate communication open (not necessarily understandable) to the patient. Dotted arrows indicate that the communication is constructed, or "censored", aimed at providing patient information on a "need to know basis" and at the same time concealing information that would cause patient concern or anxiety.

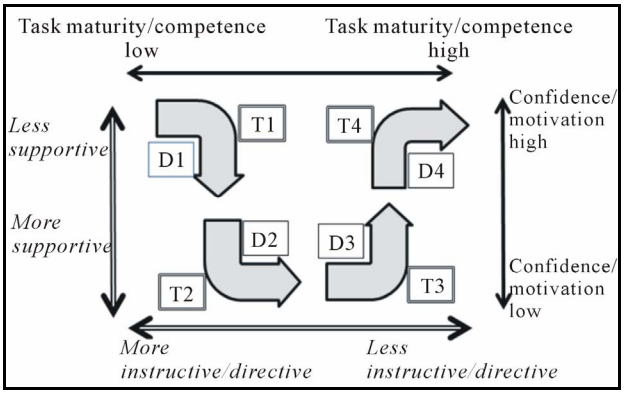

Figure 3. Schematic illustration of teaching concepts adapted from the situational leadership model. The developmental stages of the trainee surgeon (D1-D4, single line arrows and frames) are put into context with the matrix of the instructive-directive and supportive teaching concepts (T1-T4, double line arrows and frames, italics). The beginner trainee surgeon has a high motivation but a low competence level (D1). There is no need for the teacher to further motivate/support at this stage, but the emphasis is instead on instructive/directive teaching (T1). As difficulties are encountered, the self-confidence and motivation of the trainee surgeon decreases (D2), and the teacher needs to use a more motivating/supportive manner of teaching, while maintaining the instructive/directive emphasis (S2). Teaching concepts are adjusted analogously through development stages D3 and D4 (Adapted from Hershey & Blanchard [26]).

incentives for mentorship in training of surgeons [17]. How the teaching surgeon can optimize mentorship by navigating through the various learning perspectives and types of teacher-student relationship while the trainee surgeon gathers increased knowledge, skill and experience has indeed not been a common topic in the medical literature. This lack of attention to developmental stages in higher education has also been addressed by Gardner [25].

In the field of organizational management, Hersey & Blanchard coined and explored the term "situational leadership" [26]. According to their theory, a leader's behavior can be optimized by adapting to the task-relevant maturity of the person(s) subordinate to the leader. Although the validity of their theory has been challenged both theoretically and empirically, it has gained widespread popularity and application in various environments [27,28]. When applied to a surgical teaching paradigm (**Figure 3**), the task-relevant maturity of the student/learner can be divided into two factors—task maturity (capability of performing the operation) and psychological maturity (motivation level and confidence level). In the first maturity or development phase, D1, the learner has just entered the program, with a low level of competence but a high degree of motivation and confidence. The next phase, D2, is entered when initial difficulties and failures may cause severely decreased motivation and confidence in the learner. Task maturity is still low. As further experienced is gathered, competence increases, but in the third stage, D3, motivation and confidence are still on a low level, slowing the further development of the learner who is reluctant to take on more advanced tasks. With correct support from the teacher, the learner's motivation and confidence may increase, which leads to the final stage of development, D4, where the learner now has high competence, motivation and confidence. The various stages are not passed in a one-way-only manner, but there may be discontinuous leaps and back-and-forth movements.

The teacher needs to assess the trainee surgeon's level of development through phases D1-D4 according to the matrix described above, and be flexible in order to tutor optimally. As outlined in **Figure 3**, two fundamental teaching concepts are applied: instructional/directive and

Table 2. Learning perspectives, Teacher-learner relationships and situational leadership theory applications through the different phases of surgical training.

Step in training program	Learning perspective(s)	Teacher-learner relationship(s)	Stage(s) according to situational leadership theory	Teacher's approach(es) according to situational leadership theory
Evaluation/Selection of trainees	Not applicable	Teaching model	Not applicable	Not applicable
Acquisition of theoretical knowledge	Cognitive	Teaching model	D1	T1
Practical training without patient presence	Behavioristic, cognitive	Master-apprentice model	D1-D4 (modular)	T1-T4 (modular)
Clinical training with patient presence	Behavioristic, cognitive, contextual	Master-apprentice model, partnership model	D1-D4	T1-T4
Independent surgery	Contextual, cognitive, behavioristic	Partnership model	D4 (D2-D3)	T4 (T2-T3)

supportive/contextual. Initially the learner has low competence but high motivation and therefore needs instruction more than support (T1). In stage D2, there is a need for both instructive and supportive tutoring (T2), while as competence is gained the supportive tutoring is much more important than instructions in stage D3. In the final stage, D4, the teacher offers less support and fewer instructions as the trainee surgeon gains increasing independence based on sufficient competence and confidence. In the surgical teaching paradigm, the task of the teacher/mentor now changes to more organizational supportive measures, that is, assist in providing suitable working schedules and finding a new role in the organization (**Figure 3**).

7. Summary

The task of educating new cataract surgeons is necessary but also both ethically and pedagogically challenging. It is performed under increasingly demanding circumstances. In **Table 2**, the complexity of the learning process for a trainee surgeon is evident, culminating as the training takes place in the operation room with actual patients. In order to make optimal use of available structures for education such as literature, on-line resources, wet-lab facilities, simulators and patient-related activities, it can be beneficial for the teaching surgeon, the trainee surgeon and the patients as well that the teaching surgeon is aware of existing theories and concepts regarding learning and tutoring. This can improve the teaching surgeon's ability to recognize how the situation changes for the trainee surgeon during the various phases, and adapt the teaching approach accordingly in order to optimize the learning process. Studies concerning how teaching surgeons make use of various strategies during the phases that a trainee surgeon passes, and how these strategies work out, are warranted.

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