

A Preliminary Analysis of Tutorial Intervention Strategies for Teaching Decision Making in Dental Surgery

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Abstract: Most surgical simulations focus on enhancing the learning of technical skill; whereas, teaching of non-technical skills particularly decision making skills has received significantly less attention. While some computer-based system for teaching decision making have been developed, they lack the richness of interaction that occurs between student and expert in the operating room. With the end objective of developing an automated system to teach decision making skills, this paper takes a first step by carrying out an observational study of expert tutorial interventions in teaching intraoperative decision making in dental surgery. Actions and discussions were transcribed. Decisions made by novice, assistant, and interventions by expert were identified. The expert interventions were clustered into types. The situation triggering each intervention type was determined. Preliminary analysis of expert interventions identified seven types of expert intervention strategies, in which five of them were found for teaching decision making. The analysis also identified the triggering situation of each, intervention strategies usage comparison in teaching technical and decision making skill, as well as the interaction patterns of among expert, novice, and assistant. The results provide a foundation for designing the pedagogical strategies for an intelligent tutoring system for decision making in dental surgery.

Keyword: Teaching Surgical Decision Making, Surgical decision making skill, Non-technical skill, Intervention strategy.

1. Introduction

Surgical competence can be grouped into two categories – technical and non-technical skill. Technical skill or psychomotor skill relates to a surgeon's clinical knowledge, dexterity, and use of surgical equipment [1]. Non-technical skills include cognitive and interpersonal skills that complement the surgeon's technical abilities in the operating room. These non-technical skills are communicating, teamwork, leadership, and decision making [2]. In this study, we focus on decision making skill, which is the ability to consider available options, choose the option appropriate to the situation, implement the selected option, and review its outcome [1].

Surgical skill training is traditionally based on the Halstedian apprenticeship model [3], where the surgical trainee attempts to perform a task with guidance and help from an expert [4]. But shortened training programs, reduced working hours for residents and limitations on available operating room time [5] have strained this model and interest has concomitantly increased in use of simulation for training. Surgical simulation has the potential to provide students with increased training time outside the operating room,

objective assessment of procedures, and formative feedback without the need for close direct supervision of experts in limited supply [6]. But despite the fact that 75% of the important events in the operating room are related to decision making and only 25% to technical skills [7], a statistic that holds in the more specific context of dental surgery as well [8], work on surgical simulation has focused mainly on technical skills. While some computer-based systems for teaching decision making skills have been developed [9-16], they generally lack the richness of interaction that occurs between student and expert in the current apprenticeship model.

With the end objective of developing an automated system to teach decision making skills, this paper takes a first step by studying the nature of interaction between expert and students in teaching of decision making in dental surgery. In particular, based on observational data we identify seven types of interventions, in which five of them are used for teaching decision making skill, used by expert dental surgeons in tutoring students as well the conditions under which each type of intervention is used. This study forms the foundation for later automation of the tutorial strategies.

2. Related work

There have been studies of teaching in the operating room. Blom et al. [17] analyzed verbal communication during surgical procedures of laparoscopic cholecystectomies by classifying the communication in terms of the combination of type and content. The type-content classification was gained from observations of other procedures and discussions with medical experts and researchers. There were four types of communication including commanding, explaining, questioning, and miscellaneous. And the content of communication was grouped into nine domains including operation method, anatomy/pathology, location, direction, instrument handling, visualization, general, private, and undefinable. The verbal communication analysis were conducted from recorded VDO observations. And the classification results showed that each phase of the operation was dominated by different kinds of communication.

Hauge et al. [18] studied the reliability of a systematic observation instrument to identify and quantify surgeon teaching behaviors in the operating room. The instrument was developed from observations and established the face validity by several faculties and residents. The instrument had four teaching types including informing, questioning, responding, and setting tone. Each of these teaching types contained its own subtypes. The instrument was experimented by observing live and videotaped operations. The calculation of the interrater reliability and internal consistency were measured.

Roberts et al [19] proposed the BID model for teaching in the operating room. The intraoperative teaching was focused on potential symptoms and consequences of untreated pathology. The teaching strategy in intraoperative comprised immediate feedback and guidance directed by specific learning objectives and the teacher's teaching scripts.

Training surgical decision making could be done outside the operating room. Flin et al. [1] described a prototype training course of non-technical skill to increase surgeon's awareness. The part of training decision making skill was in the form of individual exercise for the group discussions of different ways in which decision can be made in the intra-operative situation.

3. Observational study

After approval from the Institutional Ethics Committee, an observational study of a teaching session at the student clinic in the Faculty of Dentistry, Thammasat University was conducted. This study used an observation of public behaviour and included no personally identifiable data. There was no data collection from the patient's perspective. The patient, expert, and students were informed for this observation. The teaching session was based on the Halstedian apprenticeship model and involved three 5th year students performing tooth extraction on a patient under the supervision and guidance of a clinical faculty member (expert) with five years experience in oral surgery. The session lasted 33 minutes. The three students had the roles of novice (dentist), assistant, and observer. The novice was responsible for diagnosing and assessing the patient's oral health needs, providing an anesthetic and carrying out the main surgical tasks. The assistant was responsible for providing support to the dentist and patient. The observer was not directly involved in the procedure and will not be further discussed in this study.

In our study, we focused on intervention strategy of expert to novice, and expert to assistant. Actions and discussions in the intraoperative training session were recorded via video, such that the recording position did not obstruct the work of surgical team. The recorded actions and discussions were transcribed. Decisions made by the novice and the assistant, as well as interventions by the expert were identified. We then sought to cluster the interventions into types in a data driven manner, and for each identified intervention type, determined the surgical skills that expert intervened for – including technical skill, communication, teamwork, leadership, and decision making, and finally determined conditions that triggered the intervention for teaching decision making.

4. Result

4.1 Expert Intervention Strategies

A total of 92 intervention instances were identified in the transcript of the training session. 71 intervention instances were related to the decision making skill. Based on the utterances and actions of expert, these 92 instances were grouped into seven types. Table 1 provides the definition and description of each intervention strategy.

No.	Acronym	Description	Definition
1	GG	Give Guidance	Providing a supportive information for the recommended action.
2	GO	Give Order	Command given for immediate action.
3	DM	Provide Demonstration	Role modeling action observable by student.
4	GA	Give Assistance	A supportive action to assist the student in carrying out a particular step.
5	GH	Give Hint	Providing incomplete information or indirect suggestion to stimulate the clinical thinking for decision making.
6	EX	Give Explanation	Providing background information.
7	GF	Give Feedback	A formative feedback on a particular step.

Table1: Expert intervention strategies in intraoperative

According to seven types of intervention strategy, there are five intervention strategies that expert used for training decision making skills. Table 2 provides five intervention strategies related to training decision making skill with a sample of the intervention.

No.	Intervention Strategy	Sample
1	Give Guidance (GG)	<p>Novice picked up a tool and was about to start opening gum, expert asked a question:</p> <p>Expert: How do you put a gauze?</p> <p>Novice: (Picked up a gauze and looked at expert. She turned to patient and then turned to expert again. She pointed at the gauze over the patient's mouth.)</p> <p>Expert: <u>At the side of the mouth.</u></p>
2	Give Order (GO)	<p>During period of using saline to clean a wound, expert found suction did not work fast enough.</p> <p>Expert: If patient close his mouth and suction after that, it will help.</p> <p>Novice: (Talked to patient) Please close your mouth. (Patient did not close his mouth as assistant was still working on the suction in an another area).</p> <p>Expert: It is like having straw in your mouth.</p> <p>Novice: (Tell assistant) Like suction like....</p> <p>Expert: <u>Close the patient's mouth, like you drink the water from straw. Let the saliva be at the straw.</u></p>
3	Give Hint (GH)	<p>After novice practiced the hand posture for tooth extraction, assistant still kept silent. Expert pointed to the patient and asked.</p> <p>Expert: <u>Is there saliva?</u></p>
4	Give Explanation (EX)	<p>Novice hesitated to start pulling the tooth. She turned to expert and asked question.</p> <p>Novice: Can we extract the tooth up right away?</p> <p>Expert: It depends.</p> <p>Expert: Are you confident?</p> <p>Novice: Oh.</p> <p>Expert: <u>If the tooth is losely for some, and it cannot extract out. Then use the forcep.</u></p> <p>Novice: Umm</p> <p>Expert: <u>It can be used. It may be difficult for the supernumerary root. You may use forcep helping in extracting tooth.</u></p>
5	Give Feedback (GF)	<p>After finishing the step of bone removal, expert examined the patient. Expert gave guidance, and novice repeated her understanding.</p> <p>Expert: Please do not try to pull the flip anymore, just relax it.</p> <p>Expert: (Looked at the novice)</p> <p>Novice: Yes. Because there is already clot, we just have to suture, and just don't make it loose.</p> <p>Expert: <u>Yes.</u></p>

Table2: Expert intervention strategies for training decision making skill with sample

Giving guidance (GG) and giving order (GO) are closely related. They differ in the specificity of directives the expert provides and the urgency expressed. Giving guidance (GG) had the lower degree of intensity than giving order (GO). In most observed instances, the expert initially gave guidance concerning the recommended action. If the student failed to follow the guidance, expert assistance was then provided. And the expert usually gave an order after the student failed to follow the expert's assistance. In cases where timely action is needed, the expert would typically move directly to give an order after student failed to correctly follow guidance.

Giving guidance (GG), giving hint (GH), and providing explanation (EX) are different in the objective. Giving guidance (GG) relates to supportive information for recommended action, giving hint (GH) relates to indirect suggestion to stimulate clinical thinking, and providing explanation (EX) relates to background information.

4.2 Triggering events for each intervention strategy

The triggering event for each intervention strategy was found by observing the situation happened before intervention. Based on the transcribed actions and discussions, the situations were clustered. The cluster of situations whose size was at least 3 were selected as the triggering event.

The triggering events or conditions for each of the five expert intervention types for decision making skill are shown below.

1. Give Guidance (GG)

There are two triggering events for giving guidance.

*1.1 Student failed to follow expert strategy of (GA, EX, GH).
(fail = incorrect response or no response)*

1.2 A task associated with an important step has been initiated incorrectly.

a.	Student is at an important step. <u>AND</u>
b.	Student already started working on this step. <u>AND</u>
c.	Working task/subtask or action is incorrect, incomplete, or missing.

2. Give Order (GO)

There are two triggering events for giving order.

2.1 Student failed to follow previous GG (in the same context).

2.2 Situation that time is running out.

3. Give Hint (GH)

There are two triggering events for giving hint.

3.1 Working task is not in good progress or having mistakes.

a.	Student already started working on a task. <u>AND</u>
b.	One of the following conditions is met. <ul style="list-style-type: none"> • Student is not making a good progress on the task. • Student failed to work on her role.

3.2 Student asks question or informs expert of her discovery.

4. Give Explanation (EX)

There is one triggering event for giving explanation.

<i>4.1 Explanation after previous intervention.</i>	
a.	One of the following conditions is met. <ul style="list-style-type: none"> • After receiving hint (GH). • After receiving assistance from expert. • After receiving guidance (GG).

5. Give Feedback (GF)

There are two types of feedback including positive and negative. From the observation, a negative feedback for teaching decision making was not found.

<i>5.1 Positive feedback</i>	
a.	After conforming expert guidance <u>OR</u>
b.	Student repeated her understanding correctly.

5. Discussion

By comparing intervention strategies of training decision making skills to the communication classification by Blom [17] and the teaching behavior by Hauge [18], there are some common intervention types. The Explaining and Commanding in Blom [17] are similar to interventions of Give Explanation (EX) and Give Order (GO) in our study respectively. Our five intervention strategies for teaching decision making are parts of the teaching behavior instrument from Hauge [18]. Giving Explanation (EX), Giving Guidance (GG), Giving Hint (GH), and Giving Order (GO) are in Instructional behavior category; and Giving Feedback (GF) is in Responding behavior category.

In our study, we did not have questioning as intervention as Blom [17] and Hauge [18]. The way we classified intervention strategies was based on discussions and actions in each decision made by students. Questions expert asked to novice and assistant implied the intervention strategies of Giving Guidance (GG), Giving Hint (GH), Giving Order (GO), and Giving Explanation (EX).

In comparison with technical skill and decision making skill, we found that expert provided demonstration (DM) and gave assistance (GA) for teaching technical skill, not decision making skill. Expert also gave explanation (EX) in teaching decision making skill, not technical skill. And expert gave guidance (GG), gave order (GO), gave hint (GH), and gave feedback (GF) for teaching technical skill and decision making skill.

The pattern of interaction between expert, novice, and assistant varied among the seven intervention types. Expert intervention could interact with the novice directly or indirectly. Expert usually provided a demonstration directly to the patient. He/she could also provide assistance while novice were working on the patient too. This allowed novice observing the interaction as learning model. Expert could also directly interact to student by giving hint, guidance, order, feedback, or explanation. Since demonstration could be occasionally provided with explanation, direct interaction to the patient and novice can happen concurrently. Figure 1-3 are diagrams of these interactions. Providing demonstration (DM) and giving assistance (GA), which are not related to decision making skill, are displayed in figure 1-2, and the rest five intervention strategies used for teaching decision making skill are represented at figure 3. The solid arrow and dash arrow refers to direct interaction and indirect interaction respectively.

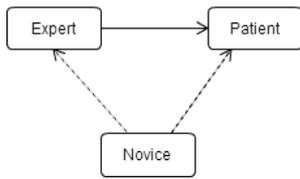


Figure 1: Interaction of expert to novice for strategy of providing demonstration (DM)

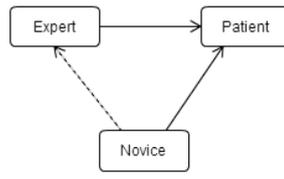


Figure 2: Interaction of expert to novice for strategy of giving assistance (GA)

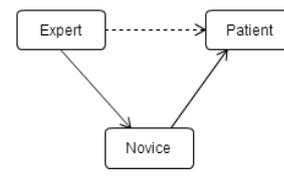


Figure 3: Interaction of expert to novice for strategy of giving hint (GH), giving guidance (GG), giving order (GO), giving feedback (GF), and providing explanation (EX)

Expert intervention could directly interact to assistant. Since assistant's task was to support overall process of the operation, assistant would directly interact to either novice (e.g. provide saline) or patient (e.g. suction), whom expert could follow up for the result of intervention. Figure 4 and 5 represent diagrams of these interactions, in which, giving assistance (GA) that are not related to decision making skill, is included.

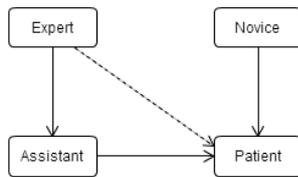


Figure 4: Interaction of expert to assistant for the task that assistant directly interact to the patient, e.g. suction. Expert intervention includes giving order (GO), giving assistance (GA), giving guidance (GG), and giving hint (GH)

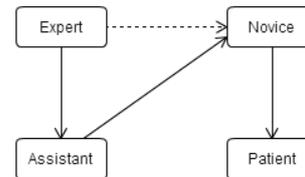


Figure 5: Interaction of expert to assistant for the task that assistant supports to novice, e.g. providing saline. Expert intervention includes giving order (GO), giving assistance (GA), giving guidance (GG), and giving feedback (GF)

6. Conclusion and Future work

Based on a study of one dental surgery training session, we initially found seven tutorial intervention strategies expert used in the operating room, we classified the intervention that expert used for teaching surgical decision making skill along with the conditions under which each was used. We compared the usage of each teaching intervention to two surgical skill – technical and decision making skill. We also found the interaction patterns among expert, novice, and assistant associated with each intervention type. Since our study is based on an observation of behavior, finding out how student think during the decision making is limited.

The future work is to do more cases on observational study and to validate that each intervention type and its trigger condition is agreed by expert. Based on the comparison with [18, 19] intervention by question is also in our consideration. An interview of the expert after observation is required to study in terms of cognitive aspect. And finally, we have to study the effectiveness of intervention strategy toward improvement of the student's surgical decision making skill.

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