



Acquisition of Competence in Clinical Practical Procedures: A Model of the University of Zambia Medical School

Katowa-Mukwato Patricia^{1*} and Banda S. Sekelani¹

¹Department of Medical Education Development, School of Medicine, University of Zambia, P.O.Box 50110, Lusaka, Zambia.

Authors' contributions

This work was carried out in collaboration between the two authors. Author KMP designed the study, wrote the protocol, wrote the first draft of the manuscript and revised subsequent versions. Author BSS guided the development of the protocol contributed to the literature searches and guided the analyses of the study findings. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To explore how medical students acquired and developed competence in selected clinical practical procedures.

Study Design: Cross sectional qualitative study.

Methodology: Seventeen (17) students from a class of 60 final year University of Zambia Medical students of the 2012/2013 academic year participated in the in-depth interviews. The in-depth interviews were conducted using Grounded Theory approach.

Results: Twelve themes emerge on how medical students of the University of Zambia, learn and develop competency in clinical practical procedures. Eight of the themes describing the process of learning, while the other four describes the process of competency development. The eight themes on learning are: learning through formal teaching, informal teaching, observing/watching, demonstration, apprenticing, and being "put on the spot". Other were learning passively and

*Corresponding author: E-mail: mukwato.patricia@unza.zm, patriciakatowamukwato@gmail.com;

learning from reading medical literature. Themes for describing the process of competency development included; personal interest, more practice, reading literature and teaching others. From the twelve themes, a new model has been advanced called “Passive Observation to Peer Teaching Model” of clinical procedural skills acquisition and competency development which describes how Medical students of the University of Zambia-acquired and developed competence in clinical practical procedures.

Conclusion: The model generated from our study can be seen as an expanded version of the “see one, do one and teach one approach” with an expansion of the “doing one” which in our model is first guided then unguided. One notable difference between existing models and that from our study is, while existing models focus on actual manipulations to perform a psychomotor skill, our model focuses on the process of acquiring and developing competency.

Keywords: Acquisition; competence; clinical practical procedures; medical students.

1. INTRODUCTION

Demonstration of proficiency and appropriate use of procedural skills pre-registration is a requirement by certifying bodies [1]. In a traditional curriculum, as was the case for more than 40 years at the University of Zambia (UNZA) School of Medicine from 1966 to 2011, medical students were expected to acquire competence in specified clinical practical procedures through the apprenticeship model using the Halstedian approach of “see one, do one, teach one” [2] as they rotated through clinical clerkships of medical and surgical disciplines.

With the Halstedian approach, clinical teaching occurs in hospital wards, General Practitioner (GP) surgeries, outpatient settings and operating theatres [3,4]. Bedside teaching has long been considered the most effective method to teach clinical skills and has numerous other benefits such as promoting ethics, humanism and professionalism, communication skills and role modeling. However, bedside teaching is increasingly becoming difficult to use due to several factors such as short hospital stays, increased service demand (workload) for clinicians, diminishing pool of clinical teachers versus increasing numbers of students, perceived inadequate preparation of students for clinical practice, increasing awareness by patients regarding their rights thus their consent to be used as part of medical education is no longer to be taken for granted [4,5,6].

Based on the above factors, hospital based bedside teaching is no longer able to provide sufficient skills experience for medical and other health care students. Thus, traditional bedside teaching based on the apprenticeship model of education alone can no longer be relied on to

provide comprehensive training in clinical skills. This situation has led medical educators to think of alternative options to ensure adequate skill acquisition by medical students. Among such options is the introduction of clinical skills centers, laboratories and more recently simulation centers with high-fidelity simulation to promote without necessarily replacing bedside teaching [4].

Medical education literature avails a number of models of teaching and acquisition of clinical skills. Kopta, [7] as cited in Hamdorf and Hall [8] outlined three phases in acquisition of motor skills: cognition, integration and automation. Cognition involves an understanding of a task. Individuals who are provided with clear description and demonstration of a task are more likely to master a skill than those who are not. In the second stage (integration), motor skills unique to the task are applied to avoid inefficient movement. In the final stage (automation) the skill becomes automatic so that there is no need to think about each step or rely on external cues.

Table 1. Stages in acquisition of motor skills by Kopta, 1971

Phase	Psychomotor element	Focus of instruction
1	Cognition	Perceptual awareness
2	Integration	Comprehension of mechanical principles
3	Automation	Speed efficiency and precision

Source: Hamdorf and Hall, 2000

While there are three stages in learning a psychomotor skill, Peyton [9] presents four

distinct phases in teaching one. Peyton [9], described an excellent and widely advocated model for teaching skills in simulated and other settings, known as the 'four-stage approach'. The four distinct phases in teaching a psychomotor skill according to Peyton include demonstration, deconstruction, formulation and performance as indicated in Table 2. Peyton's final stage of performance allows the observer (teacher) to understand in part the cognitive/ thought processes of a student that may influence skill performance while attempting to complete a task.

While Kopta's 1971 and Peyton's 1998 models were used to understand the phases for learning and teaching a manual skill respectively, three other models underpinned the study from which this article is drawn. Psychomotor learning was described using Dave's 1970 taxonomy of psychomotor domain [10], competency development as proposed by Dreyfus and Dreyfus' 1980 [11] while competence assessment by Miller's 1990 [12] model of clinical competence. Discussion related to Dreyfus and Dreyfus' 1980 and Miller's 1990 Model are beyond the scope of this article.

Dave, 1970 outlined five levels through which an individual learning a psychomotor skill progresses: imitation, manipulation, precision, articulation and naturalization [13,14]. Although Dave and Kopta's models differ with regard to the number of stages in acquiring a psychomotor skill, the underlying principles are similar. For example, Kopta's cognition stage which is characterized by perceptual awareness can be likened to Dave's imitation level. Imitation is the observed behavior underlying which are

cognitive processes such as perceptual awareness.

Kopta' second stage of integration (comprehension of mechanical principles) can be related to the manipulation level which according to Dave's taxonomy is characterized by performing skill from instruction. Finally Kopta's ultimate stage of automation (Speed efficiency and precision) can be explained by the last three levels of Dave's taxonomy (precision, articulation and naturalization).

In "traditionally oriented" medical schools, clinical skills are usually learnt by watching what clinicians do, by interviewing and examining patients and presenting findings to a supervisor [15,16]. Studies in teaching and learning in clinical setting have found that clinical teaching is variable, unpredictable, immediate and lacks continuity [17]. Furthermore, literature has alerted us that individuals who are provided with clear description and demonstration of a task are more likely to master a skill than those who are not [8]. In an environment where teaching is unpredictable and lacks continuity, it is difficult to deduce whether or not the four distinct phases in teaching clinical skills are followed or not.

For UNZA, School of Medicine, bedside teaching during clerkships was the main approach through which medical students acquired clinical skills for more than 40 years from 1966 until 2012 when a clinical skills center was established. Wholly relying on bedside teaching without any alternative to skills learning prevailed. Our study therefore sought to investigate how medical students acquired competence in selected clinical practical procedures.

Table 2. Stages in teaching a manual skill

Phase	Task	Action
1	Demonstration	Instructor demonstrates the skill at normal speed with little or no explanation
2	Deconstruction	Instructor demonstrates the skill by breaking it down into simple steps with full explanation and encouraging learners to ask questions
3	Formulation	Instructor demonstrates the skill while being 'talked through' by the student' may need to be repeated multiple times
4	Performance	Student performs the skill under supervision, describing each step before performing it.

Source: Peyton 1998

2. METHODS

2.1 Study Design

A cross sectional qualitative study design was used to investigate how medical students of the University of Zambia acquire competency in clinical practical procedures.

2.2 Data Collection

Seventeen (17) students from a class of 60 final year University of Zambia Medical students of the 2012/2013 academic year participated in the in-depth interviews. Theoretical Sampling [18] was used and it determined the sample size. Data was collected from October, 2012 to March, 2013. The first candidate for the interview was purposively selected who was the class representative and then requested to suggest the name of the next student who was to be interviewed based on the respondent's perception on who would be suitable to provide more information about how students learn clinical practical skills. Concurrent data collection and analysis was continued until the answers were no longer yielding any new information – saturation [19,20,21].

Constructivist Grounded Theory Approach was utilized considering that questions for the in-depth interviews were preconceived [22]. A total of six focused questions were asked; the first one was “ground breaking” question through which they were required to identify at least 10-14 clinical practical procedures that they felt competent in performing. The second required students to describe how they first learnt the practical procedures, the third one to describe the steps they took to develop from that initial learning to the level where they felt competent. The last three questions were used to simply understand the process of learning and assessment and its effect on the competency development.

1. Tell us at least 10-14 clinical practical procedures that you have learnt in medical school in which you feel competent.
2. Describe how you first learnt any of the identified procedures.
3. What steps did you take to develop to the level of self-competence you have reached?

4. Among the identified procedures, which ones have you been assessed on?
5. Which method of assessment was used to assess the skills?
6. Tell us any other information related to how you learnt clinical practical procedures in the medical school.

2.3 Data Analysis

Data analysis was informed by Glaser [18] in which the process of data collection for generating theory is jointly collected, coded, and analysed and the researcher decides what data to collect next and where to find the data, in order to develop the emerging theory. Using grounded theory principles [23] the data was analysed mainly through reading- and re-reading of the transcribed interviews and comparison of the transcribed interviews against audio records. Additional analysis was performed after the transcribed data was exported into **NVivo** version 10, in which the recurring terms or themes which were identified during the reading and re-reading were used as search items for identification of additional themes.

The identified themes were compared, revised and re-grouped into broader themes and coded in different nodes in the software. Finally, 12 themes were identified, eight regarding how students “first learnt” clinical practical skills and four on steps they took to develop competence on the learnt skill. Through the themes, a model of how students learned and developed competence in clinical practical skills emerged (Fig. 1 Passive Observation to Peer Teaching Model of Clinical Procedural Skills Acquisition and Competency Development).

3. RESULTS

Participants described a number of ways using a variety of words/terms/ phrases regarding how they first learnt selected clinical practical procedures. The different words/terms/ phrases used to describe how procedures were first learnt led to the emergence of twelve themes on how medical students of the University Of Zambia, learnt and developed competency in clinical practical procedures. Eight of the themes described the process of learning, while the other four described the process of competency development.

3.1 The Process of Learning Clinical Practical Procedures

3.1.1 Theme 1: Learning through formal teaching

Participants who indicated that they were formally taught describe formal teaching in different ways. Some described it in form of a lecture where students are placed in a room and taught what to do, and how to do it. Others describe it as having a tutorial where someone will be teaching the indications, when to do or not do a procedure followed by showing students how to do it, and then two or three students are expected to perform the procedure after the lecturer or the doctor. Another participant described formal teaching as not necessary being taken for a lecture but when there is patient for such a procedure, the doctor teaches the procedure. Formal teaching whether through a lecture, tutorial, or at the bedside was at times followed by a demonstration. Statements below were used to describe formal teaching in participants' own words.

I was formally taught I assume formal teaching means where you are placed in a room and told to do this or that or this is how we do it. Participant 1

For procedures like Lumbar Puncture (LP), they take it upon themselves to teach, not that they take you for a lecture, but when there is a patient for LP, they teach you. Participant 4

The one I remember is intravenous cannula insertion in surgery, we were taught by one of the interns we found there during our rotation, he first of explained to us what we were supposed to do, the approach, where you explain to the patient what you are supposed to do, the benefits to the patient and the pain they may experience. He then explained to us just by talking, then he did it himself and then gave us chance to do it one by one for the rest of the patients that need cannulation. Participant 10

3.1.2 Theme 2: Learning through informal teaching

Informal teaching was described as being taught but "Not a proper session" "Not an organized tutorial" "not organized programme" "no formal teaching or training" but where senior doctors

would "talk about" a procedure. Although some participants recommended for a more structured programme for teaching procedural skills, some preferred the informal way of teaching describing it as relaxed. Four participants described informal teaching:

There is really no formal teaching or training actually for most of the procedures. Participant 14

Once in a while the senior doctors would talk about the procedure but not really like an organized tutorial to learn about a procedure, but mostly we learn from seniors and also from your own interests but was not an organized programme that today we are going to learn how to do this. Participant 15

An informal setting and personally I prefer it like that because you are more relaxed, you are with your mentor usually not a very senior doctor, so it's more relaxing and easier to learn because most of the junior doctors we used to see them when we were junior students so it's easier to learn that way. Participant 9

But I wouldn't say we have had any serious formal classes or formal tutorials trying to explain how these procedures are done. Participant 17

3.1.3 Theme 3: Learning through observation / watching

Learning through observation or what participants referred to as "watching" or "seeing" was probably the commonest method through which medical students first learnt the different procedural skills. Mostly the students observed a few procedures being done, then attempted under supervision and eventually were able to perform with minimal supervision.

I observed what consultants or interns were doing on the ward after that I tried and repeated the same. Participant 2

All of them -cannulation, Lumbar Puncture, Nasal Gastric Tube insertion, urinary catheterization, vaginal deliveries, PAP smear, manual vacuum aspiration, suturing, I first observed then that's when I tried. Participant 5

The other one is lumbar puncture; I learnt it in 5th year in internal medicine, again it was a seventh year medical student who led me to do it. The first time I was just watching. The second time I managed to do it. Participant 6

First thing I ever did, that was in my first clinical experience in 5th year was IV cannula insertion, it wasn't taught anyway [laughter]... So we were doing a ward round and I was told to insert a cannula on a patient, so I had to figure out how to do it. I had seen it a few times when I was admitted and what I had observed and read, any way I managed but I don't think it was done the right way. Participant 7

Most of the skills I learnt by observing then trying out what I had seen, most were supervised by the Interns or nurses on the ward. Participant 13

Like for cannulation, really we were never taught on how to do it, you just observe and try to do it next time, so you see how seniors are doing and try to do it. There is really no formal teaching or training actually for most of the procedures, although you also have to go and look it up yourself it's really difficult to grasp when you read on your own. I think it was mostly from observation. Even LP, you observe and go and read on your own. Participant 14

3.1.4 Theme 4: Learning through demonstration

Demonstration was at times referred to as showing how. Those who learnt through demonstration indicated that procedures were demonstrated to them or they were *shown* how to perform a given procedure. Participants who indicated that they learnt through demonstration used the following phrases:

Nasal Gastric Tube (NGT) insertion, that was in internal medicine, it was demonstrated to us by the Nurse in Charge. She also demonstrated how to test if the tube is in. Participant 10

It was through mentorship of senior students, and intern doctors in the wards for example IV, cannulation, when I was in fifth year, a seventh year student was one who showed me how it is done, how to do, explained the procedure, the possible complications that may come, and the difficulties that you may

encounter and demonstrated once or twice. Participant 9

Then for the deliveries, I learnt from the midwives they showed me from delivering the baby, up to delivery of the placenta and finishing up the delivery. Participant 15

3.1.5 Theme 5: Learning through doing-apprenticeship

From the words used by the participant number 7, "I was assisted throughout the procedure by the Surgeon", this particular way of learning could not be categorized as either learning by observation or demonstration as the participant learnt while performing the procedure under guidance of a competent teacher (surgeon).

In surgery, the first thing was suturing, which I think I did wrongly because I had not read much about it, so I was assisted throughout the procedure by the surgeon, I think that was the first experience. Participant 7

3.1.6 Theme 6: Learning by "being put on the spot"

"Being put on the spot" denoted a situation where a student is not ready to perform a particular practical procedure. The student could have observed but not observed enough to reach a stage of readiness to attempt. One participant described how they first learnt how to insert an IV cannula by "being put on the spot".

Ok! like for cannulation, it's like I was just put on the spot, but initially I had observed a few and the next patient who came I was put on the spot, to say try to do what you have been observing, so from observation, I was told to do it. Participant 8

3.1.7 Theme 7: Learning passively

The key words that differentiated this types of learning from other types such as learning by observing is "standing there and watching someone" Standing and watching entails absence of activity possibly the reason this particular participant described it as "learning passively".

Ok let's start with cannulation, like in our curriculum we start in fifth year and I learnt it passively, it's not like someone will come

and teach you how to cannulate, you will be standing there and watching someone.
Participant 4

3.1.8 Theme 8: Learning from reading medical literature

Reading from medical literature was at times a standalone method of learning while at other time it was used to supplement what was taught, observed or demonstrated.

The first procedure I encountered was insertion of an intravenous cannula, the first time I didn't have any one to teach me per say, I was just asked to do it from what I had read from the text books so it was a bit difficult but I did manage to do it, after that I had problems until someone had to teach me how to do it using the best method and how to easily do it. Participant 11

The additional knowledge I may have on those procedures was supplemented by formal reading particularly for procedures like Deliveries, LP, pleural tap, insertion of Inter Coastal Drainage tube which I can say am also able to do. While you would be taught practical things on the ward as the procedure is being done, the information was inadequate and needed to be supplemented by extra reading. Participant 17

3.2 Steps Taken to Develop Competency in Learnt Procedures

Participants were asked about the steps they took to develop to the level of self-perceived competence they had reached. Each participant gave an account of their developmental process from "first learnt to feeling of competence". Based on the participants' accounts, four themes emerged regarding steps taken by students to reach the level of self-perceived competence from the time a procedural skill was learnt.

3.2.1 Theme 1: Personal interest

An element of personal interest in becoming competent was important for students since there was no dedicated time for learning/acquisition or development of competence in practical procedures. Participants used different phrases to denote personal interest that included "self-push" "taking it upon oneself", "self-motivation" "putting in effort" or being proactive".

I think one of the things that has helped me is my own interest, where you try to push yourself especially for those skills I learnt informally i took it upon myself to find patients or people to do the procedure on, I have been personally pushing myself.
Participant 1

Aaah, to increase my competence in practical aspect, I made sure that every time i was on the ward, I was proactive to do as many IV cannulation and blood drawings as I could and administer medication which I am allowed. Participant 2

Because if you don't put in effort to learn you will never learn because some procedures you never actually get to see them.
Participant 4

It is challenging because it almost solely depend on the individual, because if as a student you don't show any interest you can literally go through the training without learning anything, I know people who have finished fifth year without knowing even basic canulation probably they are just hiding behind others. Participant 8

From the first time I learnt, I just took it upon myself every time they would say this patient needs a cannula, I would go there of course, the first time and second time I would struggle then if I fail I would call my seniors to help but as I continued to try later on I found that I could do it. Same applies to deliveries, first time it was a bit difficult, second time but I kept on trying until now I think am competent. Participant 15

Basically I just took it upon myself to do as many as I can like for cannulation every time you are on call, you stick around the doctors, you cannulate and where you fail there is someone to assist but at least taking it upon myself to do as many as I can.
Participant 16

3.2.2 Theme 2: More practice

A number of participants described how they reached a level of competency through more practice or doing a practical procedure over and over or practicing as much as was possible. This repetitive practice was achieved through the official clerkship rotations, when students were on call, during electives or through own arrangements such as going back to the clinical

area after official school time such as during the evenings. Electives were particularly regarded as having provided more practice.

First observe, and then practice as much as you can, initially you ask someone to observe you and when you are competent you can do it by yourself. But then, the more you practice, the better you can do. Participant 3

I think it's just practice, the more you do it the better you become at it. I remember in 5th year I did a number of procedures, but then in 6th year we were not attached to any clinical setting, and when I went back in 7th year I had lost touch, I think doing it over and over again makes you better in doing these things. Participant 6

You practice, you offer yourself to practice the procedure as often as possible especially when you have stable patients you practice more, then you become better that way. Participant 9

aaah, the main thing I did is to do the procedures as many time as I could so I perfected it by doing as many times as possible. Participant 12

Yes electives made a difference in the sense that at the University Teaching Hospital, we are not allowed hands on practice but during electives you are given more time to do hands-on. Participant 1

Yes I have had electives, like in 5th and 6th year vacation you go for electives, so there you can even advance more because you even have more time to do more procedures, like catheterization, LP, even in 7th year during Community Based Education we had chance to do most of those procedures. Participant 16

3.2.3 Theme 3: Reading literature

Reading was described as one of the strategies that were used to enhance practice.

I had to read around LP literature and how they do it in an ideal way and observing more and trying to do a number. Participant 14

While you would be taught practical things on the ward as the procedure is being done, the information was inadequate and needed

to be supplemented by extra reading. Participant 17

As you may be aware, in our OSCE in Internal medicine, also in Peadiatrics there are designated stations where we are required to perform a procedure, therefore it's incumbent upon a student to look for details for those procedures because it's guaranteed that such a station would be there so it's necessary to do extra reading in preparation for examination. Participant 17

3.2.4 Theme 4: Teaching others

Some participants typically describe what is referred to as the Halstedian approach (see one, do one and teach one) in the process of developing competence. Apart from observing and performing a specific skill, some participants took a further step to teach their juniors. This type of teaching was regarding as important in their own learning and perfection of skills.

I think every time before you teach the juniors you have to be perfect you have to go back to your theory, get your theory right and even practice, I think, teaching is another way of helping you to learn and perfect a skill. Participant 9

Yes, actually we had a lot of opportunities to teach our juniors, as I said we learn from our interns, Post Graduate students, but there comes a time when there is no Interns on the ward and you are with juniors and you are doing cannulation, you teach them or if it's your turn to do a pleural tap, you call a fifth year, so someone is observing you as you are doing it and the fifth year is learning through you. It helps to gain competence. Participant 4

3.3 Passive Observation to Peer Teaching Model of Clinical Procedural Skills Acquisition and Competence Development

Based on the generated themes, a new model emerged called "Passive Observation to Peer Teaching Model" of Clinical Procedural Skills Acquisition and Competency Development. The model proposes that Medical students of the UNZA acquired and developed competence in clinical practical procedures through four developmental stages: passive observation to guided performance to unguided performance and finally peer teaching as shown in the model

(Fig. 1). The model is therefore grounded in the qualitative data obtained during the in-depth interviews. It is based upon the participants' accounts of their developmental process from "first learnt to feeling of competency".

Although all participants described the process of "first learnt to feeling of competency", presented below are participants' own words through which the model can be traced.

First observe, and then practice as much as you can, initially you ask someone to observe you and when you are competent you can do it by yourself. But then, the more you practice, the better you can do.
Participant 3

... but there comes a time when there is no Interns on the ward and you are with juniors eg the fifth year and you are doing cannulation, you teach them or if it's your turn to do a pleural tap, you call a fifth year, so someone is observing you as you are doing it and the fifth year is learning through you. It helps to gain competence.
Participant 4

I think every time before you teach your juniors you have to be perfect you have to go back to your theory, get your theory right and even practice, I think, teaching is another way of helping you to learn and perfect a skill.
Participant 9

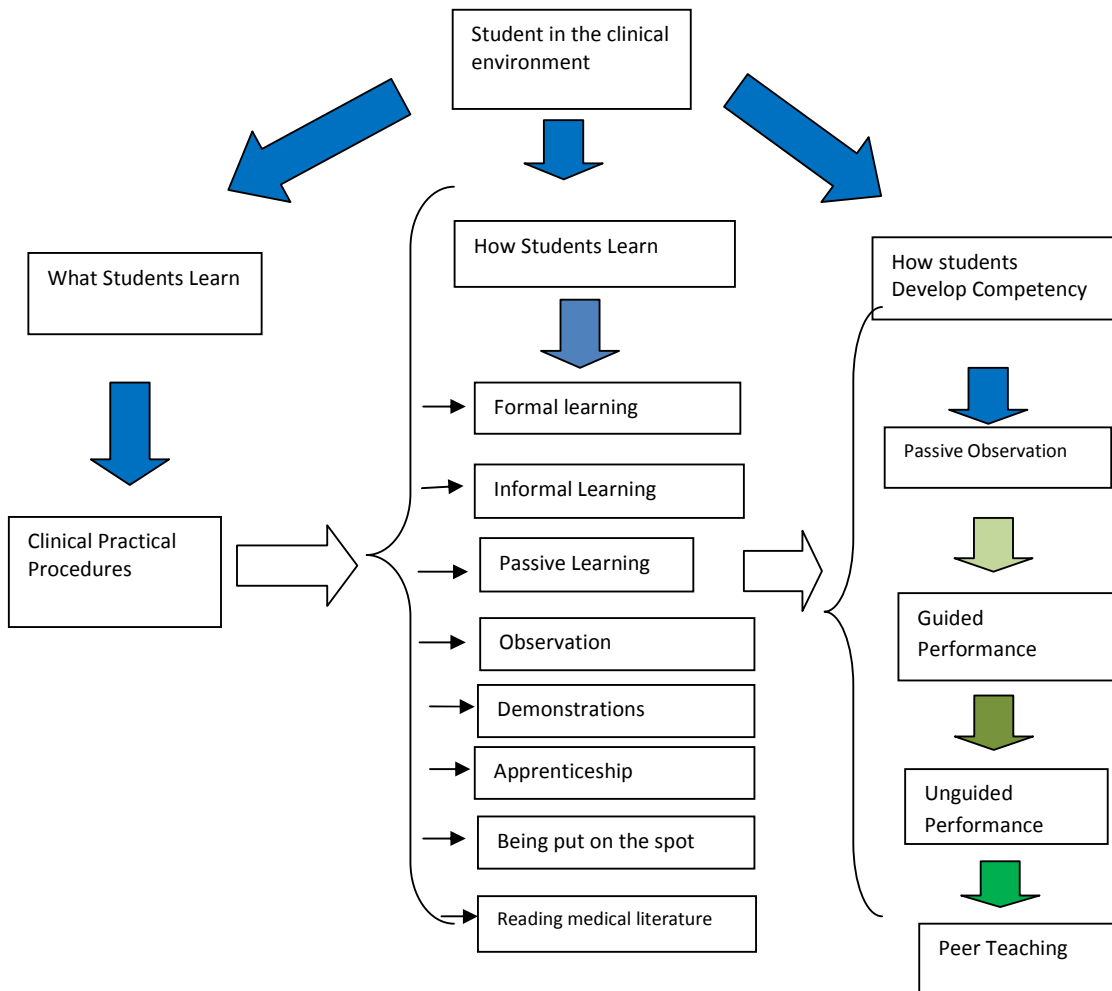


Fig. 1. Passive observation to peer teaching model of clinical procedural skills acquisition and competence development

Regardless of how medical students first learnt: formally, informally, through demonstrations, through observation, passively, by doing (apprenticeship), "being put on the spot or reading books", fundamentally they first had to observe another person perform a procedure, before they could attempt. The observation was done passively, thus the first step in the model "passive observation". Having observed once, twice or three times, how a procedure is done, the learner went on to attempt/perform the procedure under the guidance of competent practitioner. This constituted the second step in the model "Guided performance". To some learners the first attempt was learner initiated while others were requested to perform a procedure after a few observations or had to be put on the spot.

Initially you ask someone to observe you. Participant 3

But initially I had observed a few and the next patient that came I was put on the spot, to say try to do what you have been observing, so from observation, I was told to do it Participant 8.

The third step in the model is referred to as "unguided performance". Having performed a skill a number of times under observation, the learner proceeded to perform the skill unguided (more practice) when they felt competent.

Initially you ask someone to observe you and when you feel competent you can do it by yourself Participant 3.

The unguided performance was mainly self-motivated which was described as "personal interest" "self-push" "taking it upon oneself", "putting in effort" or being proactive". Students made own arrangements to practice outside official school hours "during evenings and holidays when you had to go to the wards to practice" or during electives.

Yes electives made a difference in that at the University Teaching Hospital, we are not allowed hands on practice but during electives you are given more time to do hands-on". Participant 1

The fourth and final step in the model is "Peer Teaching". This peer teaching was done by senior students to junior students. It served two purposes; junior student passively observed while the senior student "perfected a skill.

... I think teaching is another way of helping you to learn and perfect a skill. Participant 9

But there comes a time when there is no Interns on the ward and you are with junior students...you teach them. It helps to gain competence. Participant 4

4. DISCUSSION

4.1 Learning Clinical Practical Procedures

A great deal of information was generated during the in-depth interviews regarding what students learn, how they learn and how they develop from "first learnt to feeling of competency". Using Grounded Theory, a model of how Medical Students of the University of Zambia learn procedural skills emerged "Passive Observation to Peer Teaching Model of Clinical Procedural Skills Acquisition and Competency Development". All the information on the what, how and the developmental process from "first learnt to feeling of competency" built into the different components of the generated model.

The group of medical students under investigation learnt using the traditional curriculum model thus the clinical education was predominantly at the bedside during the different clinical clerkships. Traditional medical curricula rely primarily on clerkships during the clinical period of study to acquire and train in clinical practical skills. Mileder, Wegscheider and Dimai [24] affirmed that Clerkships are still the main source for undergraduate medical students to acquire necessary skills. Typically all participants interviewed learnt and felt competent in intravenous cannula insertion. Other procedures majority of participants felt competent in performing were urethral catheterization, vaginal deliveries, Lumbar Puncture, nasogastric tube insertion, and pleural and ascetic tap.

Teachers of procedural skills were mostly Intern Doctors, and to a lesser extent Senior Doctors such as Registrars and Consultants. As junior students, they also learnt a number of procedures from senior medical students. It was therefore concluded that medical students learn procedural skills from doctors at different levels. This is in confirmation with the Royal Australian College of General Practitioner [25] that Doctors at all levels of their learning lives are often involved in teaching procedural skills to their juniors: the medical student may learn skills from

the first year intern or the registrar from the vocational doctor which is reflected in the traditional expression, 'See one, do one, teach one'.

Regarding how they learnt the mentioned procedures, eight themes emerged; formally taught, informally taught, through demonstrations, through observation, passively, by doing (apprenticeship), "being put on the spot" or reading books. Irrespective of the mode of learning, fundamentally students first had to observe another person perform a procedure, before they could attempt. Initially the observation was mainly passive thus the first step in the model "passive observation". Passive observation as a mode of learning clinical practical procedures especially in junior clerkships is documented in medical education literature, for example Remmen [26] indicated that junior clerkships were predominantly passive experiences with hardly any opportunity to train in clinical skills.

Investigators in the present study believe that passive observation is an important stage which prepares the student, and allows the learner to link the theoretical knowledge to clinical practice thus moving from the stage of "knows" to "knows how" as a prerequisite to "shows how". This progression from passive observation to performance along the continuum of acquiring competency in procedural skills was observed by Johannesson, [27], illustrated that students learning procedural skills progressed from preparing, watching, practicing and reflecting. In reference to Johannesson, in our study the "watching" can be equated to the "passive observation".

Learning through demonstrations was one of the eight ways through which students learnt procedural skills. Some participants referred to demonstration as "showing how". Ideally teaching of procedural skill should progress through four stages (Table 2). In an environment where doctors who are involved in clinical medical education are also involved in full time provision of clinical care, coupled with the use of actual patients for learning, it is not feasible to follow all the four step in teaching through demonstrations. Instead a one off time demonstration usually combining step one to three (Table 2) is commonly utilized and later students are observed as they perform the procedure during the rest of the clinical clerkship. Worth noting is that at times demonstrations

were immediately followed by return demonstration which is a recommended approach and is practiced by medical educators at University of Zambia Medical School.

As expected in a traditional curriculum where medical students are expected to acquire clinical competence through the apprenticeship model [2]. Findings of our study were not different as one of the themes on learning was "learning through apprenticeship". *"In surgery, the first thing was suturing, which I think I did wrongly because I had not read much about it, so I was assisted throughout the procedure by the surgeon"*. The realization by the student that he/she did the procedure wrongly despite being assisted by the surgeon because he/she had not read, depicts the importance of cognitive knowledge in psychomotor skills [7,8,12,13, 27,28].

Following the initial learning which was mainly through observation, students had to perform the procedures under guidance of qualified clinicians. It was on the basis of this revelation that the second step (guided performance) in our model emerged. To some learners the first attempt was learner initiate. Performance of a skill by a student following observation of the teacher or instructor is recommended as a means to reinforce what has been learnt and according to Peyton [9], it is the last stage of teaching a manual skill (Table 2).

4.2 Steps Taken to Develop Competency

Four themes emerged on how students developed from the time they first learnt the procedural skill to the time they felt competent; personal interest, more practice, reading literature and teaching others. Without dedicated time for learning/acquisition or development of competency in practical procedures, personal interest was regarded as one of the major factors in the competence developmental process. Students had to take it upon themselves in seeking opportunities to practice learnt skills especially those learnt informally. Personal interest was also described as "self-push" "taking it upon oneself", "self-motivation" "putting in effort" or being proactive".

Studies in teaching and learning in clinical settings have found that clinical teaching is variable, unpredictable, and immediate and lacks continuity [17]. In an environment where teaching is unpredictable and lacks continuity, it is

definitely incumbent upon the learner to be proactive if they have to learn and develop their skills to acceptable levels. Without personal interest one participant revealed that it was possible to go through training without attempting even common procedures.

In the present study “more practice” was identified as yet another strategy towards developing competency. The “more practice” was mostly undertaken outside school scheduled learning time, thus it was student initiated and mostly unguided. It was from the “more practice” outside scheduled school time where the third step (unguided performance) in our model emerged. From the participant’s descriptions, “more practice” which was also referred to as doing a practical procedure over and over in order to be competent can be equated to the concept of deliberate practice. Deliberate practice together with other factors including direct supervision and feedback have been suggested to facilitate development of self-confidence in performance of clinical skills [29,30].

Students interviewed indicated that in order to have more practice, they had to make own arrangements such as going back to the clinical area after official school time. In addition, they had to undertake some electives, and electives were particularly regarded as having provided more practice time.

Reading was described as one of the strategies that was used to enhance competency. Students were prompted to read literature related to procedural skills due to a number of reasons. The reasons ranged from the fact that procedures in the clinical setting were not performed in an ideal manner due to limitations on resources and high patient turn over and that the information provided during the teaching sessions was inadequate and needed to be supplemented. This provoked students to read literature to discover the ideal way of performing the procedures. Another motivator for reading literature which indirectly enhanced competency was the likelihood of being assessed on procedures during OSCEs. This once more supported the notion that assessment drives learning [31,32].

Teaching others (junior students) was one of the ways in which competency was developed for some students. It is from this phenomenon where the last stage of our model emerged “peer

teaching”. This observation of senior medical students or senior doctors teaching their juniors as a means of enhancing competency is not unique to our study. As indicated earlier doctors at all levels of their learning lives are often involved in teaching procedural skills to their juniors: the medical student may learn skills from the first year intern or the registrar from the vocational doctor, reflected in the traditional expression, ‘See one, do one, teach one’ [25]. However, medical educators and medical students alike should be “alive” to the fact that most procedures need multiple repetitions of the “see one, do one, teach one” cycle to ensure proficiency in the skill [33]. The value of the “teach one” which is equated to “peer teaching” in our substantive model can never be overstated. RACGP [24] for example records that teaching is an important method of reinforcing learning in the teacher.

5. CONCLUSION

In literature, there are three main theories of how students acquire clinical competence namely Dave’s (1970) model, Miller’s (1990) triangle and Dreyfus and Dreyfus (1980) model of clinical skills acquisition, while the approach to learning in a traditional curriculum is that of “see one, do one and teach one”. From our study, a new model emerged called “Passive Observation to Peer Teaching Model” of Clinical Procedural Skills Acquisition and Competence Development. When compared to existing models of clinical skills acquisition in particular the three that underpinned our study, the main similarity is that although different terminologies are used to describe different stages of competency development, when considered in totality, the process is progressive in nature, with teaching and assessment related factors nurturing the progress. In addition the model generated from our study can be seen as an expanded version of the “see one, do one and teach one approach” with an expansion of the “doing one” which in our model is first guided then unguided. One notable difference between existing models and the one that emerged from our study is that while existing models (notably Dave’s 1970) focus on actual manipulations to perform a psychomotor skill, our model focuses on the process of developing competency.

ETHICAL APPROVAL

Ethical approval for the study was obtained from the University of Zambia Biomedical Research

Ethics Committee (UNZABREC). Approval Number: 0131212.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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