How do Saudi Board Orthopedic Surgery Residents perceive their residency learning experiences?

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Abstract

Background:

Learning in the context of residency education is built upon the foundational “premise that human beings have the ability to transfer what they have learned from one situation to another”. This study provides an in-depth understanding of the dynamics of residents’ learning processes. The main objective is to provide a theoretical foundation that describes how residents learn while being part of a complex ecological context, that is the health care context.

Methods:

The number of participants recruited in this study are fourteen residents. While qualitative research is concerned with providing rich data rather than generalized findings, the number of participants is adequate to capture the depth and complexity of the phenomenon under investigation. The participants of the study are all Saudi Residents, enrolled in the Saudi Orthopedic Residency Program. Fourteen participants consented their participation in the study, two of which are females, and the other twelve are males. Upon IRB approval, participants consented to participate in the study in the Fall 2022. Pseudonyms are used to protect the identity of participants.

Results:

The conducted interview provided rich data, and, thus, the coding of the data resulted in generating multiple themes. The researchers focused on analyzing two themes relative to the research questions. The two major themes that the researchers will discuss are: learning through surgical experiences and learning through clinical experiences. These two major themes are related to subcategories that are interrelated and overlapped. In addition, these subcategories and themes were also analyzed in terms of their relevance given the complexity of the data.

Conclusion:

In our findings, we identified and shed light on major challenges residents face in their training.

Background

Learning is a process of multidimensional, multilayered, and complex mechanisms that involve facets of cognitive, metacognitive, ecological, ideological, dispositional, identity formation, and epistemological processes.[1,2,3,4,5,6] In the context of residency education, residents are not merely learners, but accountable patient care providers. As mentors, mentees, teachers, learners, and patient care providers, residents are part of a complex ecological system that shapes their “ways of being, knowing, and moving in the world” and impacts their learning processes through a multitude of visible and invisible factors.[7]

Therefore, learning in the context of surgery residency education can be perceived as a transformative
process through which residents reconceptualize, expand, reshape, and connect their theoretical knowledge, in addition to activating and applying their surgical skills.

Learning in the context of residency education is built upon the foundational “premise that human beings have the ability to transfer what they have learned from one situation to another”. [8] Driscoll and Powel argued that this conceptualization of learning is “inadequate” into reflecting the “messy reality” of the phenomenon.[4] In the context of residency education, learning is messier and more complicated, especially while residents perform their identities as learners, teachers, and health care providers, bringing multiple dispositions, cognitive, metacognitive, and social processes. Regardless of its demonstrated complexity, the current literature has not theorized the mechanisms of learning in the context of residency education, nor the metacognitive processes involved in the process of acquiring new knowledge, applying, building upon, and expanding knowledge acquired in different educational/health care contexts.

Studies that explored the experiences of orthopaedic surgery residents have focused on examining how residents navigate the complexity of social and mental health complications while negotiating their professional identities as responsible health care providers. A thread of research has investigated the impact of burnout (emotional, physical, mental exhaustion that may lead to complete physical and psychological breakdown) on the mental health of orthopaedic residents.[9,10] Arguing for the significant impact of burnout, Al-Otaibi et al. maintain that one third of the 107 residents surveyed reported feelings of burnout, specifically feelings of low personal achievements and high emotional exhaustion.[10] Along the same lines, Koutsimani et al. argue that surgeons’ burnout is significantly associated with feelings of anxiety and depression.[11] Adding a layer of complexity, Travers demonstrates that the suicidal rate among surgeons is double in comparison to the suicidal rate of the general population.[9] These findings confirm that the learning experiences of surgeons during their residency training are complex and multifaceted, and, thus, require close examination and in-depth theorization.

Another thread of research has examined residents’ social relationships and parenthood experiences.[12, 13] Findings of Johs-Artisensi and Hansen’s study showed that residents in their study were faced with the challenge of maintaining consistent professional identity and healthy social relationships with family, friends, and significant others. Along the same lines, researchers examined factors of pregnancy and parenthood of residents during their training.[14] According to Todd et al.’s argument, surgical residents had their first child later in life and reported that the infertility rates among female surgeons are higher than the general population. These findings confirm that learning in the context of orthopedic residency constitutes multidimensional layers of complexity that shape students’ transformative process of learning. Therefore, this study is concerned with examining these learning mechanisms.

Moreover, a number of studies highlighted the research experience in residency training.[10,15] A multicenter study in Saudi Arabia shows that although residents have a positive attitude toward research, a large majority of residents are facing obstacles in conducting research. This study explains that
residents’ insufficient research skills is a major obstacle to pursue research.\textsuperscript{[10]} In addition, these researchers argue for the lack of adequate research facilities to support residents’ research experiences. Extending these findings, Mohrej et al. report that surgical residents perceive the available mentorship and faculty support to pursue research as insufficient. Mohrej et al. argue that while conducting research is one of residents’ learning curves, orthopedic residents in the Saudi Board are not receiving adequate mentorship to execute diverse and quality clinical published research.\textsuperscript{[15]} Based on these findings, research is a vital part of what learning means for residents. However, there is a lack of empirical evidence to support theorizing learning processes of orthopedic residents. Hence, this research aims at expanding our current knowledge of how orthopedic residents perceive their learning experiences while performing their identities as learners and health care providers.

A limited number of studies have explored residents’ surgical experiences. While exploring operating room learning experiences, Change et al. aim at understanding how residents perceive the learning experiences in the operating room.\textsuperscript{[16]} These researchers explain that junior and senior residents have different learning needs. Therefore, they argued that consultants should develop different learning objectives and adaptive teaching styles to meet the needs of junior and senior residents. However, the study of Change et al. collected self-administered questionnaire, which does not capture the complexity of the phenomenon of learning. Likewise, Hong et al. argued for the potential positive impact of promoting medical students’ metacognition on enhancing students’ academic performance.\textsuperscript{[17]} Despite the importance of these initial findings, they lack depth and complexity. Braun et al. discussed the concept of scaffolding, illustrating this mechanism as a form of instructions provided by “experts” to enhance how medical students “novice learners” approach their clinical cases.\textsuperscript{[18,19]} Braun et al. discussed a specific form of scaffolding in clinical context, that is representation scaffolding (case studies combined with feedback).\textsuperscript{19} Findings of their study emphasized the need to expand current theorization and theorization of scaffolding. Studies of Change et al., Hong et al., and Braun et al., contributes to theorizing the current study that aims at understanding residents’ learning experiences.\textsuperscript{[16,17,19]}

The current deficiency to theorize learning of residents undermines the transformative dynamics of learning and its multilayered mechanisms. In addition, the existing body of research overlooks the complexity of learning, focusing on limited aspects of residents’ experiences, such as their learning preferences\textsuperscript{[16]}, perception of research experiences\textsuperscript{[10,15]}, and burnout.\textsuperscript{[9,10]} None of these studies have utilized qualitative methods to collect data, and thus, not capturing the complexity of learning in residency education. In addition, none of the studies concerning learning in residency education have operated from the perspective of theories of learning and transfer. To the best of our knowledge, a theoretical foundation that is supported with empirical data to describe learning in the context of residency training do not exist. Therefore, this study allows a nuanced understanding of specific learning and transfer mechanisms that mediates residents’ complex interactions with knowledge. This understanding helps in framing pedagogical practices that are supported empirically in the context of residency education, specifically orthopedic residency training.
While it is established in the literature that surgeon experiences are important determinants of patient care outcomes\cite{20,21,22}, this study provides an in-depth understanding of the dynamics of residents’ learning processes. Building on and extending this body of research, the authors aim at exploring the learning experiences of fourteen orthopedic surgical residents enrolled in the Saudi Surgical Orthopedic Board in the Western Region of Saudi Arabia. The main objective is to provide a theoretical foundation that describes how residents learn while being part of a complex ecological context, that is the healthcare context. The main research question guided the analysis of the data is:

1. How do Saudi Board Orthopedic Surgery Residents perceive their residency learning experiences?
   a. How do they perceive their surgical educational experiences as Residents while interacting with superiors, colleagues, and patients?
   b. How do they perceive their clinical educational experiences as Residents while interacting with superiors, colleagues, and patients?

**Research Methodology**

The complexity and multidimensionality of residents’ experiences dictated the choice of the study design. The purpose of this study is to provide an in-depth understanding of the learning phenomenon in the context of residency education. It seeks to generate a theory that describes orthopedic residents’ learning processes. Among many researchers, DiCicco-Bloom & Crabtree explain that “[t]he purpose of the qualitative research interview is to contribute to a body of knowledge that is conceptual and theoretical and is based on the meanings that life experiences hold for the interviewees”.\cite{23} therefore, a qualitative design provides an adequate tool to support the purpose of the study. Specifically, the use of retrospective interviews aligns with the purpose of this study, exploring multilayered mechanisms of learning and transfer, seeking to contribute an initial theoretical lens to expand the growing body of research concerning the residency educational experiences.

The number of participants recruited in this study are fourteen residents. While qualitative research is concerned with providing rich data rather than generalized findings\cite{24}, the number of participants is adequate to capture the depth and complexity of the phenomenon under investigation\cite{25}. The participants of the study are all Saudi Residents, enrolled in the Saudi Orthopedic Residency Program. Fourteen participants consented their participation in the study, two of which are females, and the other twelve are males. Upon IRB approval, participants consented to participate in the study in the Fall 2022. Pseudonyms are used to protect the identity of participants.

A multi-level coding strategy are used to examine the interview data\cite{26}. This strategy is adequate to answer the research questions of the study concerning the exploration of learning processes. First, the interviews are open ended to identify themes and patterns utilizing the theoretical framework of learning and transfer theories\cite{5,27,28,29,30}. After a second round of coding, codes are further refined. A final round of coding is represented in the results as the major findings of the study. The multi-level coding strategy is
guided by thematic analysis informed by findings of previous studies. The themes are used to determine the patterns of learning among residents. The number of the occurrence of each code will be presented as quantitative data.

**Results**

According to Braun & Clarke researchers should be clear in describing the process through which they analyze their data and the framework utilized to analyze the data. As described in the methods section, this study utilized the Saldaña's multi-level coding strategy. Furthermore, the researchers’ understanding of the generated codes and themes are informed with Braun and Clarke’s thematic analysis framework. While using these two frameworks to guide our understanding of the data, the analysis was also informed by the research questions of the study. As explained by Braun and Clarke (2006) “a theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set” (p.82). Hence, thematization supported the purpose of the study to capture repeated patterns, and thus, propose a theoretical foundation to understand residents’ learning experience relative to the research questions of the study.

We familiarized ourselves with the data with “repeated readings,” looking for potential patterns and establishing an understanding of the conveyed meanings while drawing upon theories of learning and transfer. Two of the researchers read through the interviews to generate a general sense of the data. While reading through the data, the two researchers took notes and marked ideas for coding. In the second level of coding, the researchers negotiated the generated codes in terms of labeling the codes, revising the codes, and merging similar codes. The researchers discussed the coding categories and negotiated merging codes that underpin similar meanings under the same categories. After revising the codes and reaching an agreement on the created categories, the researchers finalized their coding system. In the final round of coding, major categories relevant to the research questions were converted into themes that represent the major findings of the study.

Reliability and validity framed our understanding of the topic we are researching and our interpretation of the data that we coded. In terms of validation, we were conscious of maintaining credibility, authenticity, criticality, and integrity. As proposed by Creswell, validation is a process through which researchers identify and utilize certain validity measures to confirm the “accuracy” of the findings. With this recognition, the study has also employed multiple strategies, such as peer reviewing, member checking, rich descriptions of participants and setting, and having an external audit. In terms of reliability, intercoder agreement was utilized through collaborative coding and checking.

The conducted interview provided rich data, and, thus, the coding of the data resulted in generating multiple themes. The researchers focused on analyzing two themes relative to the research questions. The two major themes that the researchers will discuss are: learning through surgical experiences and learning through clinical experiences. These two major themes are related to subcategories that are
interrelated and overlapped. In addition, these subcategories and themes were also analyzed in terms of their relevance given the complexity of the data.

Learning Through Surgical Experiences

Patterns of surgical learning experiences include scaffolded surgical learning, observational scaffolding, metacognitive scaffolding, and autonomous learning. Findings in regard to the theme of learning through surgical experiences were coded into multiple categories. However, we are going to present findings that relate to the theoretical foundation and research questions of the study.

Scaffolded surgical learning. This code indicates how residents describe their learning processes through surgical participation, systematic OR teaching, feedback, case discussion, and interrogation. First, in terms of surgical participation, Dr. Faisal described his involvement in a spine surgery, demonstrating:

...basically, my rotation had spine rotation. So, I was with one consultant. I felt he was very engaging inside the OR ... First of all, [he] showed me the steps on one side, on his side, and the other side, I got to do the drilling myself. And so it was a good experience. Not a lot of people experience this with spine surgery at my level...

In a similar way, Dr. Saleh described his learning through surgical participation that is augmented with the consultant feedback, demonstrating:

We had one total knee case in some other hospital, and it was planned to do the operation and through the operation it was going smoothly but then there was a small depression or let us call it something called sagittal imbalance and without the consultant help or guidance, these things for any resident is not easy to pick up so with his help the operation went smoothly after it. All of these things usually we read about it but when facing it, how to deal with it and how to remember the steps. This is the difference usually with consultant and resident who is doing this for let us say third time. This was the third time during the procedure.

Similarly, Dr. Ahmed explains his learning process through one of the consultants who function as an expert scaffolder, teaching specific prepping and draping techniques prior to OR. Dr. Ahmed’s surgical participation facilitated by a scaffolder portrayed as:

I used to be really bad, terrible in prepping and draping the patients. You know, before starting the operation, you know, when you put the iodine and the alcohol, and then you put the sheets in a specific way, we have to be really experienced at this area. Because any single step went wrong, it has to be cancelled, and you have to repeat everything ... One of the consultants, he told me come, I will teach you ... And he taught me everything. Still, I did not master because we have to get a lot of experience. But then I figured out more, then I start to be more comfortable.

The second pattern of scaffolded surgical learning as perceived by residents is integrated OR teaching. OR surgical teaching is presented in the data as a distinguished scaffolded surgical learning. This
mechanism of learning constitutes part of a complex and overlapped learning processes. Dr. Abdullah states that:

During the surgery. So until today, I can remember most of his surgeries, because I remember his talk during the surgery. He talks all over the surgery, and it is mostly scientific talk, giving his experience. Like, I remember once he was talking, we were doing the surgery. And he told me that once I had the complication, certain type of complication, because I did this during the surgery, and he showed me what he was talking about. So like, instead of directing right, he went left, because he knew that if he went left, that kind of complication will happen. So I still remember this until today, because it was as I mentioned I was more focused hearing and seeing is different than just hearing.

Along the same lines, Dr. Yousif explains a specific method of OR teaching that focuses on connecting theory to practice. He stated that:

First of all ... the approaches, he will discuss the approach with you, what you will do, like this. Maybe you will just read the approach you will not know how to apply your knowledge on the on the surgery he will discuss with you regarding the approaches, and he will tell umm.. this and this and this you have to do first of all like this, he will describe the approach practically.

Residents describe a distinctive mechanism of learning pertaining feedback based on surgical participation in the OR context. For instance, Dr. Sara explained intensive feedback to that:

He wanted to teach me the-the AO approach how you manage the patient in-the AO-the AO is our association for orthopedic. So, it is a wanted to teach me the really exact way to do things. And if we stuck what we will do? So, we stuck at that moment ... he said: “if you were alone what you will do? This is one thing you can do...He said, you know, this is one thing, so you have to take a really good view of the X-ray. You do not judge by an AP, you should take lateral and AP to see if your reduction is doing well. And we also, when you are handling the patient in the OR, you are not just handling the patients, you are handling the X-ray, you should know which degree you put your X-ray, because in short, the X-rays are tricky. If you put it in a wrong position, it will show you: “okay, my reduction is okay. My wire is- “when you take another view, it is out, it is totally out. Sometimes we put a screw, we think, okay, it is really great, when you take another X-rays. It is out of there. It is like slipped. Meaning, I am always worried about the views. So, I have to take multiple views to check my X-ray, my fixation, it is in place.

Likewise, Dr. Abdulkareem described a case in which he learned through consultants provided feedback to support the development of his surgical skills. At the same time, Dr. Abdulkareem expanded his surgical knowledge of a case complication and the adequate response to address the case. He stated:

There was a case. It was it was a femur nail. Actually, it was difficult. I did everything good. The entry point was excellent. But the problem was with the reduction, I could not do proper reduction. I told [the consultant] “I did everything good, but the reduction is not perfect. I am not happy with the reduction...He changed some changing mover tool...The maneuver that he did, it was helpful, actually. I did not know
about it before, but when he showed me and go read about it, it was not written in the book. It was written in articles and case report that if you face this problem, you should do this mover tool.

Dr. Ahmed emphasizes the importance of OR feedback. He explained that he changed the ways through which he used to go about suturing, explaining:

And then I got that feedback. It's not a life changing but I can tell you that it is a huge change. He just told me change the needle like that and goo like that and you will be safe and you're not going injure the nerves and you cannot go blindly and it will be a beautiful. After I did it, I stopped and looked at him and I said thank you. That was really changing...

Furthermore, residents describe multiple layers of constant case discussions that occur prior, during, and after the surgery. For instance, Dr. Ali describes multiple levels of scaffolded surgical learning facilitated through case discussions.

We start with the approach with discuss the case before surgery, what will do, what the step of surgery. After that I apply my knowledge to the surgery. I start with the skin incision, I can apply my knowledge to the surgery. After that after the surgery, we discuss what we are, or what we were doing through the surgery and what steps we were doing and how can avoid complication later in the same surgery. So before surgery, during surgery, and after surgery, we discuss the case.

Another example demonstrating the significance of case discussions is described by Dr. Abdullah, stating:

They do actually, because not everything is written books, especially in surgical field experiences much more appreciated. So, yes, you gain a lot of knowledge and what we care more about are skills, and skills we need more exposure and training rather than just reading. So, yes, this discussion helps a lot obviously. Especially when the person is experienced, when you hear the same thing from different kinds of, from different perspectives, the same issue for different consultants. So each have a different way of dealing with such a problem.

**Interrogative scaffolding.** The practice of interrogative scaffolding describes residents’ engagement in learning processes in which they are interrogated by an expert concerning surgical skills. Particularly, Dr. Abdulkareem described his experience with one of the consultants in the OR, stating:

Before five months ago. So we were operating on a patient. it was rare approach, rarely used approach. It was a posteriorly approach. Actually, the consultant asked me about muscle, you know this is rare approach. So you the consultant said “in my life, and I'm working 25 years now I'm working, I only face this approach two times only”. He told me “I face this approach two times, this is the second one.” So it is rare... So he asked me about certain muscle. I told him this muscle. I give him the name of the muscle. He said no. It is not it. I don't know how come this the only muscle in the posterior aspects of the knee. He said no, there is another one. I told him another one. It was completely different that I go back I read.
Because it's a rare thing. So we are not read it daily or usually. So it was a good discussion, actually, working.

**Observational scaffolding.** Another important layer of scaffolded learning is observational scaffolding that is combined with afterward case discussions and questions based on OR observations. Dr. Ahmed explains that:

It is a must. Yes. Sometimes, the consultant can do a specific technique. Usually in ortho, there is a lot of techniques. And you do not get why he did this, why he did not do that, why he chose this. So usually keep my questions at the end of the operation and then ask them why why why why why why. And he will try to explain. And usually they prefer discussion based on evidence based because I saw this in an article and you saw that in an article. I have read this and you read that but I think this one is better because it shows better technique.

Dr. Ahmed described another form of observations that are followed by surgical participation.

As I said, usually, if the operation is complicated, it's very difficult, like we're talking about an eight hour operation or a nine hour and there is a lot of neurovascular structure going on. And it's very delicate, usually my involvement, holding the retractor. And just watching, because it's really difficult, because usually the one who want to work this complicated stuff is the fellow and the consultants. The fellow wants to learn from the consultant now, because it's his sub speciality. And usually, for me, as an R3, I just watch them learn and retract and give them the view. However, simple stuff like both bone fracture here, or like intramedullary nerve for the femur or the tibia, sometimes they just take the knife and the specialist, as I told you, you can just be scrubbed in. And he will just watch. And I will do the steps completely. Because it should be if you want to be a board certified orthopaedic resident, some of the operation it should be a bread and butter for you.

Dr. Ali shared a similar perception of observations that are supported with participation and discussions.

Okay If I am comfortable so I know how to do it well I will start with his approach but his approach is new for me I didn’t do it before, so I will let him to do it first and second time I can do it, so I will not take approach in first time by myself. I will discuss also the approach with him umm.. before any surgery I read about the surgery, so I will discuss the approach I know same he will do or no and why he choose this approach, not my approach and there is any benefit from his approaches any advantages, disadvantages, any approach there is advantages and disadvantages, and we will discuss why he didn’t chose my approach and he chose his approach.

**Metacognitive scaffolding.** In this code, residents describe their engagement in learning processes in which they analyze their surgical experiences. Dr. Sara's reflection shows deep thinking processes. Dr. Sara analyzed her OR surgical experience, reflecting on her strength and weaknesses and evaluating her surgical skill:
I stuck while, so when you are doing a tibia nail. It is really great. But if you position the patient in a difficult position, you will suffer [a little bit]. So, we did not hang the patient's leg downside the bed, we put the patient leg in flexion on the bed. So, we have the OR lambs and everything above us lighting. So, when we are doing the reaming, before we do the reaming, we introduce a really long wire, a wire that will hit everywhere. So, what you have to do? that you have to touch the wire from there and bend it. So, I was doing the reaming and everyone was watching. And I released the wire, the wire just hit the lighting. You know everything is right, and- why am I hitting the light? And it is- was the only wire in the OR and we- You know, it is just like the consultant looks at me ... And with the reamer, at the same time, the reamer is stuck, and the wire hit the light. And this was really- we did not do anything, with pulled the wire out. We cut the unsterile part to reuse it. And we put betadine all over it. What to do? We have- it is the only wire. And we managed. What about the reamer? The reamer, the stuck reamer. He came and do it instead of me. But he is stuck too. He was stuck too.

**Autonomous learning.** in this theme, Residents describe their learning for OR through reading surgical references and online sources, reading about the operations, and preparing for OR.

Sara shares:

We have an AO surgical reference. So, you have to read about the operation from A to Z. This is the AO reference for operative step. What you will do, how do you start? Not this only the thing that I do. We have also multiple YouTube channels of a surgeon that doing the operations, I watch it multiple times. Watch YouTube, study for the operation before, I enter, they for- for- as a level of R1 resident, they don't concentrate how you will manage the surgical approach rather how you to position your patient on the traction table, we have something called Traction table. Because if you have a femur fracture, you have to do traction to do your reduction. How you will manage your traction table, the traction table is a hell for every resident, because it's have a lot of screws and you have to open it like this. It's really annoying. So, you have to know how to handle the retraction table, how to position your patient. The position is really important where to put your sandbags where to put the drapes, how to put the drapes, how to brim and rip these are really important things to do. If the consultant saw you do these five things, in really correct way. He knows that he will trust you. Because you know your basics. And if you know your basics that mean you already know your operation. Know what you will do. So, I never go unprepared to the OR if so, I tell them from the beginning. I didn't read about the operation. I'm just here to help. Sometimes they are really upset about this thing. But what can I do?

Dr. Faisal shares a similar perspective, arguing that independent learning creates further opportunities in the OR and bridges of trust with the consultants, explaining:

He saw that I was competent. I tried to read about the surgery beforehand and know more about the case. That's what I felt...I tried to come early, read about it, see the X rays and discuss it with him beforehand. That's why I felt he gave me more opportunity inside the OR.
Another thread of findings concerns the second major theme of learning thorough clinical experiences. The following section discusses findings of learning through clinical experiences.

**Learning Through Clinical Experiences**

Findings in regard to the theme of learning through clinical experiences were coded into multiple categories. However, we are going to present findings that relate to the theoretical foundation and research questions of the study.

**Scaffolded learning.** In this category, residents describe their engagement in a scaffolded learning process that is assisted with seniors’ feedback and discussions. In scaffolded learning, residents reflect on learning processes that occur through constant received feedback from seniors. For instance, Dr. Saleh describes how case discussions during on calls contribute to the growth of residents in terms of managing the cases and receiving feedback. Dr. Saleh explained:

Most discussions will happen through the on calls, because it is critical for [the residents] to manage their patients. And it is critical for [the residents] to learn what they are seeing, because they will see it through their residency and throughout their career. If they cannot recognize the cases, if they can not recognize the proper management of these cases, the patient will be affected. So number one is on call, so usually the junior will present a case in the ER. He will discuss with the senior the plan and after the plan is carried out, if the senior felt that the junior does not know what is the diagnosis and why is the plan is carried out this way, not the other way. Usually, he will let him read for 30 minutes, the subject in general and then they will discuss each point. And the management for each patient, these kinds of things.

Reflecting on different layers of learning, Sara depicts learning through presentations and case discussions. Similar to Dr. Saleh’s perception, Dr. Sara emphasized the significance of learning while managing cases during on calls. Sara’s perception shows that she learns through a cycle of exposure to patients, gathering evidence to present cases at regular endorsement meetings, and receiving constant feedback from seniors at these various cycles of learning. Dr. Sara describes morning meetings through which case discussions occur and the dynamics of expert-novice scaffolding during these meeting as a valuable source of learning and development of surgical skills. Dr. Sara describes her learning experience in morning sessions as:

So, the morning meeting, we are like medicine people in the orthopedic, we took three hours in the morning meeting just to discuss our cases. It is a long time, but I really, I saw it really great. Because we learned a lot. And if I did not answer the question that is forwarded to me. See, maybe the hospital that I was in is really good- have a really good environment. They do not like yell at you. They do not embarrass you ... They know that you are an R1 resident, your knowledge is a little bit not that much at the moment. So, they ask the R2, then the R3 ...

Dr. Saleh describes specific teaching strategies that consultants utilize to scaffold teaching in case sessions, saying:
We had one, some other hospital we had one session of teaching and one of those residents was supposed to give the teaching. And there was a consultant whose subspecialties is the same topic that we are discussing. And whenever each point in the discussion, he will stop everything and they will discuss with us, you understand it and we will explain. So if the information can be carried out with a simple word, with a simple imaging, with a focus or emphasis on things that need to be emphasized on. And whenever the engagement by the consultant, the whole session changed, he asks [the residents] simple questions in regard of whatever was explained in the last 30 minute. If [the consultant] found any hesitation or any misunderstanding, he will try to explain the subject by using some pictures either by drawing either by showing them on some models that he brought.

In many of their reflections, residents describe the ways through which their learning is scaffolded and the impact of the received feedback in reshaping their clinical practice based on re-understanding or re-connecting their clinical and theoretical knowledge. Dr. Abdulkareem describes a moment of scaffolded learning while interacting with one of the consultants, stating:

Two years ago, when I was in R2, there was a case in clinic. It was an arthroplasty joint replacement. So at that time, I just finished R1; it is not that much of knowledge. So I take history and examination from the patient. I saw the X-ray. The consultant came in the clinic and he asked me, “What is your prime diagnosis?” So I told him what is my prime diagnosis. He saw the X-Ray, he took history from the patient. It was completely different from my decision at this time.

In alignment with Dr. Abdulkareem’s perception, Dr. Ali describes perceived scaffolded case discussions as significant to his growth as an orthopedic surgeon. Specifically, Dr. Ali explains how one of the consultants scaffolds his learning in a way that improves his clinical decision making:

When I am involved, I can discuss the case with the consultant … sometimes I took decision but sometimes [the consultant] direct me to another decision that I did not know about it. In books, they sometimes direct us to some points, but with experts the consultant they read a lot of research and they direct us to other decisions, so I think … when I discuss the case with the consultant in the group, I improve my clinical decision.

Similarly, Dr. Abdulkareem describes a specific learning experience, through which he learned how to read the x-ray, explaining:

My diagnosis was wrong…osteoarthritis. My diagnosis was completely different. I thought that was a fracture. That was not the fracture. It is a bone formation callous. First, after we finished the patient, and sent him home, he sat with me and he explained to me on the X-ray on the computer, show me this is X-ray with an old age. This is not a fracture, this callous or this bone formation, just come with the old age patient because it is more common … It changes a lot of things, actually, it changes a lot of things in my mind … How to read, how to see the X-ray. At that time also, he said describe the X-ray… So this an AP view patient. Okay, and there is a fracture. so yeah, he directs me to how different thing about reading,
how to read the X-ray, a proper reading this X-ray, starting by patient information, confirming his name, diffuse, at what level, what are the bone shown in the X-ray, view which view, et cetera.

**Initiated scaffolded learning.** Residents describe their engagement in an initiated clinical practical learning process that is assisted by experts’ and seniors’ feedback and discussions. Residents describe how they take the initiative in learning through preparation, reading, and interacting with patients and their involvement in discussions and feedback with their seniors. Dr. Sara explained a process in which she initiated her learning process through history taking, examination, and diagnosis. This initiated learning was scaffolded with the Consultant’s feedback. Dr. Sara explained:

... I check the patient first. See what is wrong with him, hear about his history, full history, do the examination, try to find out what is the problem, then I go to the specialists or the consultant that is by me. And I explained everything to him the examination, my findings, everything he came by, and I tell him that, for example let us suppose that this patient have plantar fasciitis. And I think the best way for this patient ... to do for him referral to the physiotherapy ... [the consultant] said “tell me why did you say that he has this kind of diagnosis, why not this kind.” So, we in the clinics, always we always discussing with each other ...

Dr. Sara further describes her initiated learning scaffolded by experts’ feedback. She elucidates:

Let us suppose that the patient has a femur shaft fracture, it is femur shaft fracture, it is an obvious you know how to manage a femur shaft fracture, first of all, for history, know what is happening to this patient? Check if there is another fracture check what is the mechanism of injury, then you apply your skin fraction, you have to manage your patient before you even talk to a specialist. So after we manage everything, I am talking to the specialist, sent him everything, I told him, I will admit the patient for pain management for surgical fixation, anticoagulation and every everything that I will do, and you will agree with me, sometimes ...

Dr. Faisal shares a similar perspective, describing the importance of being a proactive resident. Dr. Faisal stated:

...Usually you have to be more involved and more proactive by yourself, you have to go and ask and see. And tell them what you think. And afterwards in the results if you have a surgery or not, so you have to put yourself more involved, see the post-op X-Ray, comment your comments, think: “Is this supposed to happen or not? Was there another option?”

**Interactive scaffolded learning.** In this category, residents describe their engagement in learning processes in which they function as a member of the clinical decision making. For example, Dr. Saleh describes:

One example was intraoperative case, we had one case with infected periprosthetic fracture and the decision making in that case intraoperatively was to remove the implant and after discussion with the consultant and I tried to convince him that the patient should need further management with something
else. The decision was slightly changed to put it instead of one or two stage operation to make it a three stage operation. And that was very recently and we have in the ER, the ER management as a senior resident actually, our recommendation to the consultant usually will be carried out because we are as the eyes in the ER. In daily manners as a senior resident, your decision will make a huge difference because usually the consultants are not available in the day to day basis.

A similar perception of interactive scaffolding is described by Dr. Maram. As shown in the following example, Dr. Maram shows her perception of learning through participating as a member of the clinical decision making. She explains:

... We had one patient; he had an open tibia fracture. So, the management was open reduction internal fixation and the patient had skin defect. So the plastic intervene and they did skin graft. So, the patient after 5 days had skin graft rejection. So, the patient was admitted for 3 months with us and we had to do debridement. Due to infection, we had this failure, and the decision was to do debridement till there is on infection and then plastics would muscle flap, and till 4 months we couldn't get negative culture. The management plan was to remove the implant and maybe the infection would go and the plastics could go ahead, if not then we need to amputate. I argued with them as to remove the implant and give the patient a trial and see it would be better without the amputation and now the patient is stable.

Dr. Abdullah describes his involvement in the treatment plan, stating:

Like if the patient presented, next day in the morning meeting, we will be asked about the trauma itself and to describe the trauma, the classifications and then we get involved in the treatment plan, we get discussed about it. And the decision usually is made mostly by the consultant and specialist, they listen to our suggestions, but the final decision is for the, mostly for the consultant.

**Collaborative scaffolded learning.** In this category, residents describe their engagement in practicing and expanding their knowledge while interacting as junior and senior residents. In the following example, Ahmed describes his approach while functioning as scaffolders who are practicing their knowledge.

So for example, if we had a case from the ER, they call us from the ER, they say we have a bone fracture, we do not go directly to the case. I hold the Resident by himself, we open a website called ortho bullets, then we open the subject. And now we read it completely. And then the junior he will go down. And he will see and re-evaluate the case, if he does his full examination. Once we finish I will come and I will repeat the whole scenario, then we'll check the missing stuff, what he did wrong or what he did right. And then after that, we'll discuss the management, we'll discuss the plan and then we will discuss the theoretical parts of the surgical part, these kind of stuff. Unless if it was dislocated or need to be reduced or something open fractured, hands on teaching is a must.

Likewise, Dr. Salih describes his learning through interacting with juniors. While practicing his prior knowledge, Dr. Salih, as a Senior Residents, emphasis that learning occurs through discussions with younger residents.
sometimes we will discuss with some junior resident who prepared well in certain topics and he will open your eyes on a new data that is presented in certain research. And you will discuss with him, read it together... So number one is oncall so usually the Junior will present a case in the ER. He will discuss with the Senior the plan and after the plan is carried out, if the Senior felt that the Junior does not know what is the diagnosis and why is the plan is carried out this way, not the other way. Usually, he will let him read for 30 minutes, the subject in general and then they will discuss each point. And the management for each patient, these kinds of things.

Similarly, Dr. Jad reflects on his experiences with teaching younger residents. Dr. Jad showed consciousness of the significance of teaching good patient care to younger residents. He stated:

I think one of the things that I try my best to explain to myself first and to then secondly is to have a really good patient care which is not an easy thing especially if you have lots of cases and lots of patients and really bad workload, try to explain to them that please be patient as you can as much as you can. Umm.. Try to give the maximum care that you can give try to bear the load of the patients, especially when some patients are I mean, not all the patients are the same some of them are needy, some of them are really sensitive, some of them are really well educated and you cannot tell him something and he cannot totally absorb, some of them are poorly educated, some of them like.. you can see all types of people. So I tell my residents always my junior residents especially, to be patient as much as they can in regards to all patient experience patient interaction with the doctor's experience.

Dr. Sara describes learning with her senior residents. Similar to previous examples, residents create knowledge collaboratively. Dr. Sara states that:

Uhm- maybe let's fi- we have one case in the ward. And I, this is the first time I saw this-this case, they discuss with me this case and explain to me, [meaning] one of them was a girl like me, we always have our room. So, we open the X-rays. We read it together. She told me how to manage this case, how many times she saw it in the OR? What is the complication that they face during the OR time? The same with the boys, we have a board in the on-call room of the boys, we discuss sometimes how to manage the patient, how we will do this and that, uhm- yes, it's like this. [meaning] it is not- it is not pure learning rather than we are talking about the cases. [meaning, it's friendly] it's not direct teaching or something.

Dr. Abdullah shares a similar perspective, stating that:

Sometimes [junior residents] know more than us, they read more, so definitely they know more, the only difference is experience as I mentioned. They could help and give me information I didn't know about, reading wise. And I would give them the experience they didn't have the chance to. So yeah, junior residents, to me they are colleagues. So it is like give and take both directions.

**Interrogative scaffolded learning.** The practice of interrogative scaffolding describes residents’ engagement in learning processes in which they are interrogated by an expert. For example, Dr.
Abdulkareem described his learning while the Consultant was analyzing the case and the resident’s plan through a series of questions that validate his diagnosis and treatment plan. He explained:

I called directly the consultant he asked me “Why do you want to go conservative for this patient?” So I told him “I want to go [conservative] because old age, has a lot of comorbidities I think we will compromise his health and his skin and for infection for further complication. So as for this patient, I will choose conservative management.” He said “okay, will you decide conservative management and you told the patient that you will give a chance for conservative management, so how you gonna follow him up in the clinic?” I said “okay, I will give the patient two weeks OBT, I will assist him again, I will remove the cast in clinic, I will do X-Ray without cast. I will see if there is any callous formation, any proper healing, anything, I will start support supplement for the patient”, so he agreed for my plan.

In a similar vein, Sara demonstrated the constant questioning that she receives from her superiors. Dr. Sara emphasizes the importance of being prepared to address any of the questions raised by consultants. Dr. Sara describes:

…I read the X-ray. Okay, now, tell me how would you fix this fracture? So, I told him maybe I will fix it with intramedullary nail. Reckon kind of type. I will use two screws up two screws down. Okay, [you are correct], okay. You are in a good way. So how what is your approach? So, the approach is everything in orthopedic. If you don’t know the approach you don’t know orthopedic, from the end. And the anatomy, the anatomy, they ask anatomy a lot, a lot. Even the smallest bone in the body. They ask about it. The surfaces, the ligaments, the muscles. The blood supply, the nerves. So, in the morning, in the morning meeting, you have to suspect that they will ask about everything. So, you have to be prepared. So, you’re on an on-call, you are so tired and you’re studying at the same time. Rounds! and rounds, even in the rounds. You admit these patients, you already have an admitted patient before. So, we will do rounds to these patients. You have to know everything about the patient…

Dr. Abdulkareem and Faisal described this type of scaffolding in different learning situations, such as being in the ER:

So from ER, When I call: “Yes, doctor, hello, I have patient, taken history, examination, X ray reading, what the patient has,” okay. He asked me “Okay, so what is your plan? As ER management, and then as inpatient management, what you want to tell the patient? Would you consent the patient, consent him for what? What you want to do for the patient? What would you go for conservative or Operative management?”

Dr. Faisal’s demonstration shows a process of feedback through asking questions, discussions, and feedback. Dr. Faisal explains:

They would ask me: “what do you think?”, and I will start making discussion and from that discussion, we will get results, and he tells me: “yes I agree with you” or “no.” This is during clinics.
In the above section, the researchers explicate findings that are relevant to the research question of the study. The following section represents discussion of major findings.

**Discussion**

Findings of this study confirm the complexity of learning and the depth of its multifaceted and multilayered mechanisms.\cite{1,2,3,4,5} It confirms Change et al. findings that OR teaching has a significant impact on students' learning experiences.\cite{16} However, the current study provides nuanced understanding of specific OR teaching practices. It describes the integration of practical demonstration that is combined with verbal explanation. Furthermore, it specifies how OR teaching facilitates the connection between theory and practice. This adds to our understanding of specific pedagogical practices that can be adopted in the OR context.

Consistent with previous studies\cite{18,19}, the current study reveals scaffolded learning patterns. On the other hand, the current study extends current understanding of scaffolding, while building upon the concept of metacognition\cite{5,17,34}. Specifically, it proposes the process of metacognitive scaffolding, adding a nuanced understanding of scaffolding from the perspective of metacognition. Future studies may focus on exploring specific metacognitive scaffolding mechanisms, such as metacognitive knowledge and metacognitive regulation. Exploring these metacognitive patterns is significant because of their impact on learning and transfer \cite{17,19,34}. Building upon the concept of scaffolding the current study proposes interrogative scaffolding, observational scaffolding, collaborative scaffolded learning, and interactive scaffolded learning. Further studies may investigate the impact of these different types of scaffolding on the development of residents' surgical skills.

Consistent with findings of previous studies\cite{5}, this study reports on complex learning pattern that emphasized the importance of connecting theory to practice. Specifically, residents in this study describes moments of “re-seeing” previously required knowledge while participating in a community of practice through which knowledge is created collaboratively. These moments of reconceptualization or connecting their theoretical to practical knowledge can be perceived as transformational. Throughout a hierarchy of complex cognitive and metacognitive learning processes, residents’ reconceptualization of their knowledge takes the forms of expanding and reshaping previously acquired knowledge. In addition, part of these complex learning processes involves the activation of theoretical knowledge through practical experiences.

**Conclusions**

Our study is the first of its kind in the region to explore such various dimensions of orthopaedic surgery trainees. In our findings, we identified and shed light on major challenges residents face in their training. We hope more efforts be made on having individuals highly dedicated to tracking the learning experiences of the residents and ensuring that they are able to achieve their education competencies from all its aspects, particularly research.
Declarations

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All authors declare no competing interests

Availability of Data and Materials

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