SELF-REGULATED LEARNING MICROANALYSIS FOR THE STUDY OF THE PERFORMANCE OF CLINICAL EXAMINATIONS BY PHYSIOTHERAPY STUDENTS

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Abstract

Background Understanding how health sciences students learn to perform clinical examinations is required to inform feedback that improves performance. Self-regulated learning (SRL) is an essential component of effective feedback. The key self-regulated learning processes can be identified using microanalysis. Self-regulated learning microanalysis is increasingly used to assess and inform the training of clinical skills in medical education but there are no studies on the use of self-regulated learning microanalysis to understand the performance of clinical examination by physiotherapy students. The aim of this study was to evaluate the feasibility of using self-regulated learning microanalysis to understand how physiotherapy students use key self-regulated learning processes while performing a clinical examination. Method SRL microanalysis assessed the self-regulated learning processes of second year physiotherapy students of a Spanish university (n= 26) as they performed a goniometric evaluation. An analysis of inter-rater reliability was also performed to evaluate the degree of agreement among raters. Results There were differences in the use of key self-regulated learning processes between successful (n= 15: 57.0%) and unsuccessful performers (n= 11: 43.0%), with differences in strategic planning, self-monitoring and the self-evaluation phases. There was good inter-rater reliability for scoring strategic planning (k=0.792), self-monitoring (k=0.946) and self-evaluation (k=0.846). Conclusion SRL microanalysis is a feasible approach to identify the key self-regulated learning processes of the performance of clinical examination by physiotherapy students. Further research with larger number of students and a variety of tasks is recommended.

Background

Competency-based education (CBE) is gaining attention in physical therapy (PT). It may help to meet societal demands for developing better professionals [1,2]. It may also improve competence in psychomotor skills [3]. Using CBE, students' progress depends on their ability to master a skill or competency [4]. Demonstrating ability requires PT trainees to take charge of their learning process [5].

Self-regulated learning (SRL) is a meta-cognitive process that mediates learning [6]. It has been defined as 'self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals [7]. Learners who self-regulate engage in goal-directed behaviours, use specific strategies to attain goals, and modify their goal-directed behaviours or strategies to optimise learning [7].

The SRL model is grounded in social cognitive theory [7,8]. It recognizes 3 cyclical and iterative phases in the self-regulatory process: forethought, performance, and self-reflection [9]. In the forethought phase, which takes place before the start of the task, learners anticipate the nature and complexity of the task at hand, set goals, and make specific plans to ensure appropriate performance [8]. The impetus for a learner to invest the necessary effort to engage in self-regulation is determined by self-motivation beliefs, such as self-efficacy, goal orientation, and task interest or value [10]. In the performance phase, self-regulated learners focus on monitoring their act and make adjustments to enhance performance. This uses strategies such as attention focusing, relaxation, positive self-talk, and mental rehearsal of the steps of a procedure [11]. In the self-reflection phase, after the task is concluded, learners self-evaluate and reflect on how they can enhance future performance [11].

Self-regulatory assessment

Although self-regulatory processes are metacognitive and therefore not amenable to direct observation, some assessments can capture the self-regulatory processes that individuals employ to perform a specific task [6]. Such assessments diagnose otherwise imperceptible difficulties, providing unique information that may enhance feedback to the learner [12]. Self-Regulated Learning Microanalytic Assessment Training (SRL-MAT) is an analytical approach designed specifically to evaluate how learners self-regulate across the three phases of the cycle [13].SRL-MAT entails observing and interviewing learners using "think aloud protocols" and real-time observation to evaluate their use of key SRL processes [6,10]. At predetermined moments, answers to questions related to the forethought, performance, and self-evaluation phases are collected and subsequently analysed [14]. SRL-MAT contrasts with approaches that rely solely on questionnaires, which are not designed to capture the entire SRL cycle and are subject to bias related to the beliefs of an individual in self-efficacy or attribution bias [15].

There is strong evidence across a range of diverse contexts, from academic studies to music education, and athletic training, that SRL has an important contribution to make to both understanding and enhancing performance by providing specific feedback on key SRL processes [10,7,16,17]. In health care, Cleary and Sandars (2011) [18] have investigated the SRL process in students performing venepuncture.They found that students with higher levels of strategic thinking before, during, and after the venipuncture performed better than those with low levels of strategic thinking [18]. A narrative review of published meta-analyses of feedback interventions in education and a systematic review of effective remediation interventions in medical education has highlighted the importance of enhancing performance feedback with feedback about the use of self –regulated learning (SRL) elements by students [19,20].

Objectives

Although the importance of SRL in clinical performance is recognised, SRL has not been previously studied in PT Education. Physical therapy and health sciences education may benefit from using SRL for understanding and enhancing performance of clinical skills. We conducted this study to evaluate the feasibility of using SRL microanalysis to understand how physiotherapy students use key SRL processes while performing a specific clinical examination task [17]. We chose goniometry for our study, as this is a common clinical task in PT training internationally. This study was designed as a feasibility study, in preparation for a larger intervention study [21].

Methods

Research design

This was an exploratory study of the feasibility and utility of SRL microanalysis to differentiate key task specific SRL processes of PT students.

Participants and setting

Participants were undergraduate physiotherapy students (n=26) in their second year at the Faculty of Health Sciences, University of Las Palmas, in Gran Canaria, Spain. Students were recruited at the conclusion of a lecture by the first author (RM). The general nature of the study was explained without passing on specific information about SRL. All participants had successfully concluded the subject "*Valoración en Fisioterapia I*" (Assessment in Physiotherapy 1) UNESCO code 3211.11, within the previous three months, in which they had performed joint goniometric measurements similar to the task used in this study. Of the 26 participants, 19 were female (73.7%) and 7 were male students (26.9%). They represented 38.8% of the second-year physiotherapy class.

The goniometric task

In physiotherapy, goniometry is used to assess the range of motion of a joint by measuring the angle of motion [22]. It is a well-defined task within international physiotherapy curricula, as described, for example, in the Canadian physiotherapy curriculum [23]. The task required students to obtain a goniometric measurement of the shoulder joint of a peer. This task included several actions: positioning of the peer into a correct posture, setting the goniometer in the correct position, moving the joint correctly through its range of motion, and obtaining the measurement of the range of the angle of shoulder flexion [22].

The self-regulated learning microanalysis protocol

The SRL microanalysis protocol followed health sciences education guidelines [11]. Before the start of the interview, the task was described by the interviewer. The students were asked to rate their self-efficacy in obtaining the measure correctly on a scale from 0-10. They also answered the strategic planning question: "Do you have any particular plans about how you will obtain the measurement? "After answering the question, students performed the task. After positioning the goniometer and prior to making any joint movement in the peer, they answered the self-monitoring question: "Do you think you have performed a flawless process so far or have you made any mistakes? Tell me about them". Finally, upon task completion, two questions were posed focusing on self-evaluation. The first question was "How satisfied are you with your current performance?" They were requested to evaluate their satisfaction with their performance on a scale from 0-10 (Zimmerman and Kitsantas, 1999). The second question was: "What criteria did you use to determine your satisfaction?" Then, students were asked to rate their self-efficacy on a scale from 0-10 [24]. (Table 1 near here)

Data collection

Two experienced physiotherapists (RM and DA) agreed on the expected standard of performance prior to the observations of the physical examination. They assessed the performance of each student independently as correct or incorrect. The interview questions were asked by one assessor (RM). All answers were audio-recorded and transcribed by the first author (RM). Each SRL microanalysis session lasted from 3 to 6 minutes.

Data analysis

Content analysis

The coding scheme was established prior to the observation of the physical examinations. It was adapted from existing SRL-MAT research [13,14,11]. The responses to the open questions (items 2, 3 and 6) were coded independently [18] by two authors (RM and DA). The inter-rater

agreement was calculated using kappa coefficients. Differences in coding between examiners across all SRL measures were resolved through discussion among the authors (RM, DA and MJC).

Answers to open question were coded into the following categories:

- Strategic Planning: 1) Positioning the patient (patient focus); 2) Technical performance using the goniometer (technique focus); 3) Patient and technique combined; 4) Without a plan; 5) Do not know
- Self-monitoring: 1) not aware of any mistakes; 2) mentions procedure related mistakes; 3) non-procedure related mistakes; 4) do not know.
- Self-Evaluation: 1) learning originating from theoretical lectures; 2) learning originating from practical sessions; 3) learning originating from both theoretical and practical sessions; 4) Other; 5) Do not know.

Quantitative analysis

We first paired pre and post examination ratings for the same students and then studied the dataset to check for missing data and to examine the normality of variables. The scores were compared through a paired t-test and Cohen`s D test [25]. We also evaluated internal consistency through Cronbach's coefficient. We used SPSS 21.0 to calculate descriptive and inferential statistics, inter-rater agreement, and internal consistency.

Results

Qualitative analysis

Task performance

There were 15 students (57%) who were successful and 11 (43%) students who were unsuccessful in the correct performance the goniometric task. There were proportionally fewer female students in the unsuccessful group (n=7) 63.6% compared to the successful group (n=12) 80%.

Forethought phase

In the forethought phase, statements made by most successful students [14:15 (93%)] revealed they planned the task, which was not the case in unsuccessful students [6:11 (54%)]. The plans described by the successful students were in three categories: positioning the patient (patient focus) and correct technical performance using the goniometer (technique focus) combined (n=6, 40%), technique focus (n=3, 20%), or patient focus alone (n=5, 33.3%).

This is an example of a statement on focusing on the technique made by successful student:

017*: "I think I have a plan ... I put the goniometer first. I would ask him to raise his arm and measure it. "*

This is an example of a statement on focusing on the patient made by a successful student:

020*: "First I place the stretcher at a comfortable height, I ask the patient to get into the most comfortable position and explain what he has to do. He should be comfortable".*

This is an example of a statement on focusing on both technique and the patient made by a successful student:

015*: "Yes, I have a plan. First, I place the patient in a supine position, to be comfortable and I adjust the stretcher. Then, I put the axis of the goniometer on the lateral side of the humerus, the fixed arm parallel to the midline of the humerus... The fixed one remains there, and another moves parallel to the midline of the humerus. And I ask him for the flexion movement. And I measure it"*

In the forethought phase, six (54.5%) unsuccessful students were unable to explain their proposed action or stated they had no strategy for performing the task. These students were categorised as "Without a plan." The plans of unsuccessful students could also be categorized into technique (n=2, 18.9%), patient (n=1, 9.1%) or technique and patient (n=2, 18.9%). Only one student who performed the task successfully did not state that they would prepare for their performance.

Performance phase

The narratives of successful students were very detailed, revealing that students were attentive to the details of their performances. Successful students mentioned they were under the impression they had committed a mistake (n=9, 60%), related to the procedure (e.g., incorrect/imperfect

positioning of the goniometer (n=6, 40%) or to their own posture or the position of the bed (non-procedural) (n=3, 20%). In contrast, none of the students who were unsuccessful could recognize their mistakes. Only one student who performed the task successfully did not state that they self-monitored their performance.

This is an example of a comment about a procedural mistake:

06: "I made mistakes; I think ... I have to put the goniometer in this way… I am not considering the alignment of the goniometer..."

This is an example of a non-procedural mistake regarding posture:

26: "I think I am making mistakes in my posture ... maybe my leg on the stretcher."

In contrast, unsuccessful students either explicitly mentioned they had not committed mistakes (n=5, 46%) or they were unable to answer the question (n=6, 54.5%).

This is an example of an answer of an unsuccessful student:

07: "*I do not know if I have made any mistakes..."*

Self- evaluation phase

There was little difference in answers by successful or unsuccessful students to the question on self-evaluation. Successful students (n=7, 47%) were mostly focused on the importance of paying attention in lectures. An example was:

026*: "what I remember from lectures…I should put it in the right way and if it should go in the arm or move or not..."*

This finding suggests that the student had internalised the task to a level of expertise and the key SRL processes had become routinized. For more microanalysis procedure details see table 2 and 3. (Table 2 and 3 near here)

Quantitative analysis

Reliability

The inter-rater kappa coefficients for strategic planning (0.792) , self-monitoring (0.946) and self-evaluation (0.846) were high. For internal consistency, an alpha-Cronbach coefficient of 0.846 was obtained for quantitative items, self-efficacy prior to the task, self-efficacy post-task and satisfaction post-task.

Self-efficacy and satisfaction assessment (motivational beliefs)

Both groups showed high and similar self-efficacy (SE) scores before starting the task. The median scores of successful and unsuccessful students were, respectively, 6 and 8. After the task, the SE scores were higher for successful students (median = 8) than unsuccessful students (mean = 7). The differences between self-efficacy scores pre and post task were statistically significant (t=2.613, p=.015) with a medium effect size (r=0.45) [25], between the high and low performers.

There were three unsuccessful students with high SE scores (SE=9) before starting the task who were unable to complete the task. After the task, two of these students reduced their self-efficacy scores but they were still high (SE=7). The other student maintained a high SE score after an unsuccessful performance (SE=9). The student who maintained a high SE score, had a planned patient/technique focus ("*First I position the patient and explain what kind of movement is, then I place the goniometer and measure*"). The student also self-evaluated satisfaction based on lectures and practical lessons ("*I have learned this in lectures and teachers have explained this in practical lessons too*"). However, he was not aware of making mistakes when self-monitoring his performance ("*I do not know if I am making mistakes.*"). These findings suggest that the student was overconfident and poorly calibrated in his initial and final SE judgments in relation to his performance on the task.

Satisfaction scores were significantly different between successful (mean=8.07) and unsuccessful students (mean=6.27) (t=2.663, p=0.014). The range of satisfaction scores was higher in successful students with a minimum score of 7 and a maximum of 10. In unsuccessful students the satisfaction scores ranged from 0 to 9.

Discussion

The findings of this study suggest that SRL microanalysis can identify differences in the key SRL processes used by physiotherapy students as they engage in a clinical examination task. The high inter-rater reliability found in the analysis of the SRL microanalysis data by two independent evaluators suggests that different assessors can use the protocol coherently. Our findings also pointed to differences in key SRL processes between high and low performing students. This work provides support that SRL microanalysis is a useful protocol to generate information on the key SRL processes of physical therapy students. This is consistent with previous work with medical students [13,14,11,26]. Whereas most successful students mentioned a plan at the start and paid attention to process-related mistakes during performance, most unsuccessful students had not planned the task before the start, and all were unable to identify their mistakes during performance. Published literature shows that individuals who focus on their plan and objectives make better cognitive adjustments to control whether the task is performed adequately, compared to those who do not plan the activity [27,28]. The consistency of our findings with previous research suggests that similar findings may also occur with studies performed on other clinical tasks in PT or in other areas of health sciences education. The self-efficacy scores were high in some students, despite their unsuccessful performance and one unsuccessful student has increased his/her self-efficacy score after the performance of the task. Therefore, those students had calibrated their performance inappropriately and the completion of the task by itself did not change their evaluation [29]. These students might have completed the goniometric task but had no awareness that they were not capable of performing the task independently. It is likely that such students had not received feedback to develop their awareness during their studies. Under such circumstances, SRL microanalysis has potential to be a useful technique to enhance and individualize student feedback [12].

The integration of SRL microanalysis in regular teaching sessions has the potential to improve learning in all students, particularly in poor performers, by offering specific information to enhance performance. The incorporation of SRL microanalysis in the diagnosis of difficulties in student performance could enhance the effectiveness of remedial programs, by informing and directing the feedback to aspects that students need to address [12,19]. The assumption that students can develop key SRL processes is aligned with the idea that SRL interventions are one form of helping students develop as independent, lifelong learners [30].

Weakness and strengths

Although this study used a small sample from one institution, the findings of this study support the feasibility of using SRL microanalysis for the identification of the use of key SRL processes by physiotherapy students while performing a clinical examination.

A feasibility study evaluates the potential for introducing an approach into a larger exploratory or intervention study. Feasibility was inferred from the low time and space demands of performing a SRL microanalysis, and the high inter-rater agreement of scoring between examiners. In this study, less than 5 minutes of student and observer time were sufficient to obtain useful information on the use of key SRL processes. This would not have been obtained by relying on student self-assessments or a post-task interview. In addition, the setting and the materials were identical to a regular skill training space. Even if educators may initially find that implementing SRL microanalysis is time consuming, it is easy to reduce the time required by repeated practice [12]. Educators can adapt the SRL microanalysis protocol to their teaching circumstances with potential gains for student development.

Future Research

Further research with more students and different tasks is recommended to confirm whether the microanalysis protocol is equally feasible and useful with other clinical tasks. Intervention research to evaluate the impact of SRL-enhanced feedback on the performance of clinical examination skills in physiotherapy [31] will require larger studies in different settings.

Conclusions

Our findings suggest that SRL microanalysis is potentially a useful approach to provide feedback on performance of clinical examination skills in physiotherapy. Further research is recommended using different clinical examination skills in physiotherapy to evaluate the impact of SRL-enhanced feedback on performance.

Abbreviations

SRL: Self-regulated learning. CBE: Competency-based education. PT: Physical Therapy. RM: Raquel Medina. DA: David Álamo. MJC: Manuel João Costa. SPSS: Statistical Package for the Social Sciences. SRL-MAT: Self-Regulated Learning Microanalytic Assessment Training. SE: self-efficacy

Declarations

Ethics approval and consent to participate

The Ethical Committee of Human Research of the ULPGC granted ethical approval for the study, reference CEIH-2018-01. All participants provided informed consent.

Consent for publication

All data are de-identified

Availability of data and materials

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest

The authors declare that they have no competing interests.

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Tables

TABLE 1. SRL Microanalytic Assessment protocol.

SRL Phase	SRL Sub process	Measure/Questions	Timing of administration	Coding Scheme
Forethought	Self-efficacy Pre-Task	Scale 0-10	Pre-task	0-10
	Strategic Planning	Do you have any particular plans for how to take data about the joint grades?	Immediately preceding the first attempt to take the measure.	1) Patient focus 2) Technique focus 3) Patient care and technique focus 4) No plan 5) Do not know
Performance	Self-monitoring	Do you think you have performed a flawless process thus far or have you made any mistake? Tell me about them.	After the measure began but prior to obtaining goniometric grades.	1) Not aware of any mistake 2) Procedural mistake 3) Non-procedural mistake 4) Do not know
Self Evaluation	Satisfaction	How satisfied are your current performance? Scale 0-10	After the task was completed.	0-10
	Self-evaluation	What criteria did you use to determine your satisfaction?	After satisfaction question	1) Lectures 2) Practical lessons 3) Lectures and practical lessons 4) Other factors 5) Do not know
	Self-efficacy Post-Task	Scale 0-10	After self- evaluation question.	0-10

TABLE 2. Qualitative variables: Strategic planning, Self-monitoring and Self-evaluation.

	QUALITATIVE ANALYSIS	SUCCESSFUL (n)	UNSUCCESSFUL (n)	TOTAL
STRATEGIC PLANNING COODING	Patient care	5	1	6
	Technique	3	2	5
	Patient care and technique	6	2	8
	No plan	1	6	7
	Do not know	0	0	0
	TOTAL	15	11	26
MONITORING CODING	Not aware of any mistake	5	5	10
	Procedural mistake	6	0	6
	Non-procedural mistake	3	0	3
	Do not know	1	6	7
	TOTAL	15	11	26
SELF-EVALUATION CODING	Lectures	7	2	9
	Practical lessons	2	0	2
	Lectures and practical lessons	1	3	4
	Other	2	3	5
	Do not know	3	3	6
	TOTAL	15	11	26

TABLE 3. Examples quotes in each phase differentiated by successful and unsuccessful students.

PHASE	CODING SCHEME	EXAMPLES SUCCESSFUL QUOTES	EXAMPLES UNSUCCESSFUL QUOTES
FORETHOUGHT PHASE: Do you have any particular plans for how to take data about the joint grades?	1) Patient interaction/care	*020. First I place the stretcher at a comfortable height, I ask the patient to get into the most comfortable position and explain what he has to do. He should be comfortable".*	*013. "I have to tell the patient what I am going to do, put him in a good position and perform the task."*
	2) Technique	*017."I think I have a plan ... I put the goniometer first. I would ask him to raise his arm and measure it. "*	*011. "Yes, I follow the bony regions and how is the movement to apply the tool".*
	3) Patient care/ technique	*015."Yes, I have a plan. First, I place the patient in a supine position, to be comfortable and I adjust the stretcher. Then, I put the axis of the goniometer on the lateral side of the humerus, the fixed arm parallel to the midline of the humerus.. And I measure it"*	*003. "First, I prepared the patient, and then I allocate correctly the goniometer"*
	4) Any plan	*030. "I have no plan right now"*	*021."I am not thinking about a plan right now"*
	5) Do not know	*No examples*	*No examples*
PERFORMANCE PHASE: Do you think you have performed a flawless process thus far or have you made any mistake? Tell me about them.	1) Not aware of any mistake	*006: "I made mistakes, I think ... I have to put the goniometer in this way… I am not considering the alignment of the goniometer..."*	*009. "No, it is correct"*
	2) Procedural mistake	*026: "I think I am making mistakes in my posture ... maybe my leg on the stretcher."*	*No examples*
	3) Non-procedural mistake	*030. "I thin it is correct"*	*No examples*
	4) Do not know	*012. "I am not sure…I do not know"*	***07:*** *"I do not know if I have made any mistakes..."*
SELF-EVALUATION PHASE: What criteria did you use to determine your satisfaction?	1) Lectures	*026: "what I remember from lectures…I should put it in the right way and if it should go in the arm or move or not..."*	*009. "The knowledge learned in lectures"*
	2) Practical lessons	*030. "The concept learned in the practical lessons and practical exams"*	*No examples*
	3) Lectures/ practical lessons	*020. "In what I have learned in lectures and practical lessons during the year"*	*013. "Beacuse I have learnt how to do it in lectures and practical lessons"*
	4) Other factors	*016. "First of all, I were insecure with the goniometer and then I realised my mistakes.."*	*007. "I observed my performance and I*

			realised my mistakes"
	5) Do not know	*015. "I do not know exactly.."*	*021. "I do not know….I do not remember…"*