Directed Teaching of Clinical Reasoning in the Fourth Year of Medical School: A Structured Summary of Genetic Observations

L'enseignement dirigé du raisonnement clinique en quatrième année de médecine: Le résumé structuré d'observation en génétique

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Abstract

Introduction: Clinical reasoning (CR) encompasses diagnostic activity, treatment planning, execution, and monitoring, as well as prognosis establishment. It is a skill that needs to be taught rather than left to chance. Clinical rotations provide an ideal learning environment for CR.
Aim: To evaluate a directed teaching (DT) approach for CR learning, using structured summary of observation (SSO), based on a known case during a genetics rotation for fourth-year medical students (MS4).
Methods: This was a longitudinal, descriptive study involving MS4 on a genetics rotation during the first semester of the 2020/2021 academic year. Three DT sessions were conducted, focusing on the development of SSOs to teach Down syndrome, Turner syndrome, DiGeorge syndrome, and fragile X syndrome. The pedagogical approach was evaluated based on the grades assigned to the SSOs, a comparison of pre- and post-test averages, calculation of the relative gain for the average grades of the three DT sessions, calculation of the Cohen's d effect size, and calculation of the heterogeneity rate. Student evaluation of the teaching approach was done through a satisfaction questionnaire.
Results: Forty-nine students divided into 10 groups of four to six students participated in three DT sessions. The average grade for the SSOs was 14.12 [10.75-16.5] (p=0.15). The average grade for the pre-tests was 9.3 [7.16-11.23] (p=0.13), and for the post-tests, it was 13.22 [11.93-14.59] (p=0.034). The relative gain for the average grades of the three DT sessions was 35.81% [10.9-65.78]. The heterogeneity rate was 21.98% for the pre-test averages and 12.6% for the post-test averages. The Cohen's d effect size was 2.06. Analysis of the student satisfaction questionnaire showed that the overall appreciation of the DT sessions was very satisfactory in 85% of cases.
Conclusion: DT for genetic diseases using SSOs had a positive effect on the acquisition of new theoretical knowledge in the short term. This active learning method was well-received by the majority of students.

Key words: Teaching, learning, clinical reasoning, clinical case, clinical training rotation, genetics.

Résumé

Introduction: Le raisonnement clinique (RC) englobe l'activité diagnostique, la planification, l'exécution et le suivi du traitement, ainsi que l'établissement du pronostic. Il s'agit d'une compétence qui doit être enseignée plutôt que d'être laissée au hasard.
Objectif: Évaluer une approche d'enseignement dirigé (ED) pour l'apprentissage du RC, en utilisant un résumé structuré d'observation (RSO), au cours d'un stage en génétique pour les étudiants en médecine de quatrième année (MS4).
Méthodes: Il s'agissait d'une étude longitudinale et descriptive impliquant des MS4 au cours du premier semestre de l'année universitaire 2020/2021. Trois séances d'ED ont été menées sur la réalisation de RSO pour enseigner quatre syndromes génétiques. L'approche pédagogique a été évaluée par les notes attribuées aux RSO, la comparaison des moyennes des pré- et post-tests, du calcul du gain relatif pour les moyennes. L'évaluation de l'approche pédagogique par les étudiants a été réalisée à l'aide d'un questionnaire de satisfaction.
Résultats: Quarante-neuf étudiants répartis en 10 groupes de quatre à six ont participé aux séances d'ED. La moyenne des RSO était de 14,12 [10,75-16,5] (p=0,15). La moyenne des pré- et post-tests était de 9,3 [7,16-11,23] (p=0,13) et 13,22 [11,93-14,59] (p=0,034) respecivement. Le gain relatif pour les notes moyennes des trois séances était de 35,81% [10,9-65,78]. L'appréciation globale par les étudiants a été très satisfaisante dans 85% des cas.
Conclusion: L'ED des maladies génétiques utilisant le RSO a un effet positif sur l'acquisition de nouvelles connaissances à court terme. Il a été bien apprécié par la majorité des étudiants.

Mots clés: Enseignement, apprentissage, raisonnement clinique, cas clinique, stage clinique, génétique.

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Introduction

Knowledge has long been regarded as an accumulation of knowledge transmitted from the Master to the Student, with the Student becoming a Master in turn once they have received everything (1). This empirical pedagogical approach is based on a linear relationship between a knowledge transmitter, the Master's brain, and a blank receiver, the Student's brain (2). During the teaching of sciences in general and medicine in particular, lectures enable students to engage in passive learning, mainly based on memorization (3). Furthermore, lectures only allow for the achievement of educational objectives at Bloom's level 1 of the knowledge domain (4). Since the reform of medical studies at the Faculty of Medicine of Tunis (FMT) in 1988, new pedagogical methods have been developed. Their purpose is to improve the learning of clinical reasoning among students (5), and they are increasingly used at the FMT as a replacement for lectures (6). Among these methods, we mention case-based learning. Indeed, the use of real clinical cases is recommended to increase students' interest in their own learning and, above all, to stimulate the clinical reasoning necessary for problem-solving. The goal of learning from real cases is to help students learn the skill of clinical reasoning by emulating the expert's thinking processes (7). The aim of this study was to describe a directed teaching (DT) approach to post-hoc argumentation of the solution to a known diagnostic clinical case for students on a genetics rotation, using structured summary of observation (SSO), and to evaluate this DT approach among the students.

Methods

We conducted a longitudinal, descriptive study that focused on the directed teaching (DT) of genetic diseases using real patient records. These patients had consulted at least twice at the Genetic Department at Mongi Slim Hospital: once for clinical examination and genetic testing, and a second time for result disclosure and genetic counseling. The study involved fourth-year medical students (MS4) from the FMT who were assigned to the Genetic Department at Mongi Slim Hospital during the first semester of the 2020/2021 academic year. Each week, we received a new group of medical students for a period of four days.

Organization of Teaching

We organized a DT approach to prepare students for subsequent problem-solving exercises. Since very few genetic diseases can benefit from treatment, the steps of clinical reasoning focused on learning the diagnostic approach and making decisions regarding paraclinical investigations. It involved a diagnostic reasoning exercise and post-hoc argumentation of clinical cases where the diagnosis was already known to the student. The selection of teaching topics was based on: (i) the objectives of the clinical rotation, (ii) the most commonly encountered genetic pathologies in pediatrics, and (iii) the pathologies studied in the self-learning mini-module (SLM). The selected topics were Down syndrome, Turner syndrome, DiGeorge syndrome, and fragile X syndrome. Students were asked to prepare the corresponding topic for each pathology before attending the DT session. The structured summary of observation (SSO) form was adapted from the one proposed by Professor ChedlyTabbane in his book titled "Introduction to medical education workshops" (6). The development of this new form was necessary to add essential data related to the genetic record (specialized complementary examinations, genetic counselling, prenatal diagnosis) and remove other data that are less frequently recorded in routine practice (treatment, prognosis). This form allowed for a succinct mention of essential details related to the reason for consultation, diagnostic-relevant information from the medical history, diagnostic-relevant findings from the physical examination, diagnostic-relevant investigations (genetic and others), genetic counselling, and prenatal diagnosis. For each DT session, a pre-test and post-test were developed based on the educational objectives of the SLM. The tests consisted of the same multiple-choice questions (MCQs), with the number of questions ranging from eight to nine depending on the pathology. The tests were validated by two instructors and were used to assess the impact of this type of DT approach on the acquisition of new knowledge. The student evaluation questionnaire or satisfaction test was used to anonymously evaluate the following four items: (i) organization of the teaching, (ii) relevance of the teaching, (iii) student involvement, and (iv) instructor involvement. A section for remarks and suggestions was also included in the questionnaire. Students' evaluations were noted using the modified four-point Likert scale (8) to avoid null ratings.

Teaching Process

The DT sessions were conducted in several steps: administering the pre-test, reading the case file and completing the structured summary of observation (SSO) form, correcting the SSO forms using a pre-established grid, discussing the answers in a plenary session with the aid of illustrations, administering the post-test, and correcting the post-test in a plenary session. The evaluation of the DT by the students took place at the end of the final session. The duration of each DT varied from 1 hour and 10 minutes to 2 hours, depending on the topics. The tests and SSO forms were corrected using a criteria-based grid. Written consent was obtained from the students who wished to participate in the study after explaining its purpose to them.

Learning Evaluation

This evaluation corresponded to Level 2 of Kirkpatrick's model (9). It aimed to assess the relevance and usefulness of the SSO in the process of acquiring new knowledge. The acquisition of new knowledge by the medical students from the FMT in the field of genetics

was evaluated using the following parameters: (i) a comparison of the average scores obtained in the pre-test and post-test, (ii) the average scores of the four SSO forms calculated per student and per group of students, (iii) an analysis of the learning effect by calculating the relative gain (RG) between the pre-test and post-test (10) using the following formula:

$$RG = \frac{\mu\ posttest\ -\ \mu\ pretest}{maximum\ score - \mu\ pretest} \times 100$$

RG: relative gain
μ: average score of the three DTs
(iv) determining the effect size (11) of the learning process by calculating Cohen's d index (12) using the following formula (12):

$$d = \frac{\mu\ posttest - \mu\ pretest}{(\sigma\ pretest + \sigma\ posttest)/2}$$

d: effect size of the SSO
μ: average score of the three DTs
σ: standard deviation
A positive learning effect was considered when the RG was greater than 30%. The effect size was in the desired range if d exceeded 0.6. The coefficient of variation was calculated to assess the degree of agreement among the students. Agreement or homogeneity was considered significant when the coefficient of variation was below 15%, while above 30% indicated considerable disagreement or heterogeneity (13,14).

Results

Each week, a new group of students from FMT was assigned. In total, we conducted DT sessions with 49 students divided into 10 groups of four to six students each. SSO 1, 2, 3, and 4 corresponded to the case files of trisomy 21, Turner syndrome, DiGeorge syndrome, and fragile X syndrome, respectively. The average score out of 20 for the four SSOs across all groups was 14.12 [10.75 - 16.5] (Table 1). The average score out of 20 for SSO 1, 2, 3, and 4 across all groups was 13.95 [10 - 18], 14.38 [10 - 19], 15.21 [6.5 - 19.5], and 12.92 [8.5 - 17.5], respectively, with a p-value of 0.0087.

Table 1. Distribution of average scores obtained in SSO 1 to 4 by group.

Groups	SSO average	Min	Max
1	14.05	12.88	15.38
2	14.69	12.38	15.63
3	14.07	13.13	15
4	14.9	13	16.5
5	14.31	14	14.5
6	13.47	12.5	14.13
7	15	13.63	16.5
8	14.33	13.38	15.63
9	13.71	12.13	16.5
10	12.63	10.75	14.63
1-10	14.12	10.75	16.5

SSO : structured summary of observation

The average score out of 20 for the pre-test and post-test was 7.45 [1.25-15] and 11.58 [7.5-15], respectively, for DT1. The remaining results for DT2 and DT3 are summarized in Table 2.

Table 2. Statistical parameters of scores obtained in pre-test and post-test.

		Average	Median	SD	Min	Max	p value
DT1	Pre-test	7.45	6.88	3.52	1.25	15	< 0.0001
	Post-test	11.58	11.25	2.19	7.5	15	
DT2	Pre-test	11.57	11.25	2.75	6.25	17.5	< 0.0001
	Post-test	13.94	13.13	2.8	8.13	20	
DT3	Pre-test	9.09	8.89	3.62	1.11	17.22	< 0.0001
	Post-test	14.15	14.44	2.46	6.67	18.89	

DT: directed teaching; **SD**: standard deviation

The average score for the pre-tests across all groups and all DTs was 9.3 [7.16 - 11.23] out of 20 with p = 0.13. The average score for the post-tests was 13.22 [11.93 - 14.59] out of 20 with p = 0.034. The analysis of the learning effect per student was performed by calculating the relative gain (GR) for the average scores of the three DTs. In our series, it was 35.81% [10.9 - 65.78] (Figure 1). It exceeded 30% in 36 out of 49 cases (73.4%).

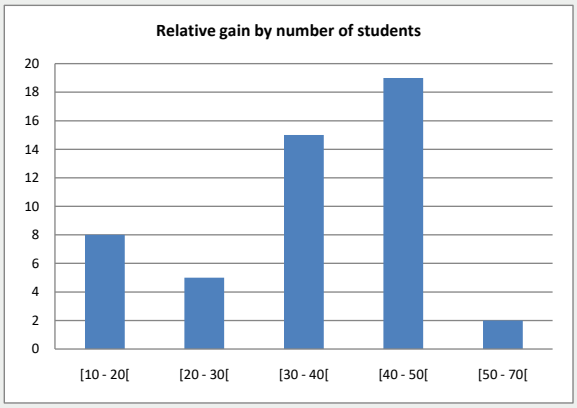

Figure 1. Distribution of Relative Gain based on the Number of Students during Genetics DTs using SSOs.

To determine the effect size in our study, we calculated the overall Cohen's d index, which was 2.06 (Figure 2). It was greater than 0.6 in 47 cases and greater than 1 in 41 cases.

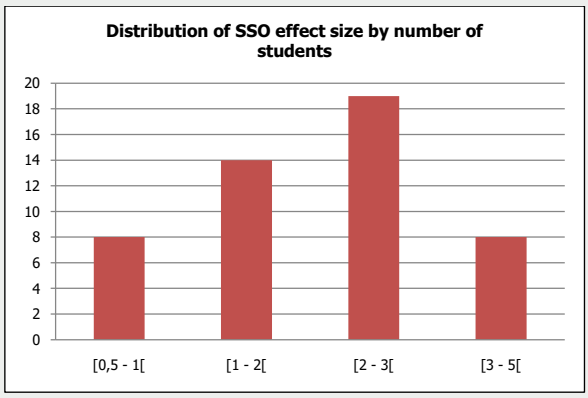

Figure 2. Distribution of the effect size of RSO in relation to the number of students during genetic ED sessions in the form of RSO

In our series, the heterogeneity rate was 21.98% for the mean of pre-tests and 12.6% for the mean of post-tests.

The ratings on the satisfaction questionnaire ranged from -2 to +2, indicating complete disagreement or complete agreement, respectively. The average score for all 10 questions was 18.33 out of 20, with scores ranging from 13 to 20. The average scores per question ranged from 1.31 to 1.98 out of 2 (Table 3). The overall evaluation of the DT sessions by the students was highly satisfactory in 84.7% of cases and satisfactory in 14.5% of cases (Table 3).

Table 3. Degree of student satisfaction according to the modified Likert scale and item-specific scores assigned by the students during genetic DT sessions in the form of SSO

	Totally disagree N (%)	Rather disagree N (%)	Rather agree N (%)	Totally agree N (%)	Scores
1- Objectives were clearly stated	0	0	2 (4)	**47 (96)**	1.96
2- The framework was appropriate	0	0	4 (8)	**45 (92)**	1.92
3- The programme was respected	0	0	2 (4)	**47 (96)**	1.96
4- The level of student involvement was high	0	**3 (6)**	**25 (51)**	21 (43)	**1.31**
5- Teachers were always available	0	0	1 (2)	**48 (98)**	1.98
6- The slideshow was clear and well illustrated	0	0	10 (20)	**39 (80)**	1.80
7- The time allocated was sufficient	0	**1 (2)**	8 (16)	**40 (82)**	1.78
8- Students acquired new skills	0	0	3 (6)	**46 (94)**	1.94
9- The DT sessions were an advantage over the SLM.	0	0	7 (14)	**42 (86)**	1.86
10- The students were satisfied with their participation in the DT	0	0	9 (18)	**40 (82)**	1.82
Overall rating	0	0.4 (1)	7 (15)	**42 (84)**	**18.33**

DT:directed teaching; **SLM**:self-learning module

Discussion

We organized directed teaching (DT) sessions to introduce MS4 at FMT for clinical reasoning (CR) learning in genetics. Forty-nine students, divided into 10 groups, participated in three DT sessions. Through this study, we demonstrated the contribution of structured observation summaries (SSOs) in self-learning new knowledge about the most common genetic diseases. The exercise involved diagnostic reasoning and retrospective argumentation of clinical cases whose diagnosis was known to the student. The evaluation criteria for students and the performance indicators of the DT sessions using SSOs included the comparison of pre- and post-test averages, which showed a significant improvement. The student evaluation of the DT sessions showed that all students agreed on the value of DT in acquiring new knowledge, the contribution of DT compared to SLMs, the relevance of the slide content, and the clarity of teaching. The overall assessment of the DT sessions by the students was highly satisfactory in 41 cases (84.7%).

Our study had several strengths, including:

- The small number of students per group, not exceeding six, which allowed for better learning and interaction among students and between students and the instructor.
- The diversity of topics covering the most frequently encountered genetic pathologies in pediatrics.
-The use of an evaluation grid and a clear scoring system for correcting tests and SSOs, which ensured objective grading despite the involvement of two different instructors in supervising the students.

However, our study had some limitations, including:

- The use of MCQs as a means of evaluating clinical reasoning: MCQs are quick to read and answer for students, and quick to correct for instructors. However, this method is not highly recommended for assessing CR compared to other methods such as script concordance tests (SCT) (15), complex MCQs (15), or patient management problems (PMP) (16).
- The lack of comparison of this teaching method with other learning methods for CR.

These limitations highlight areas for future improvement and research. It would be valuable to explore alternative assessment methods that better capture the nuances of CR. Additionally, conducting comparative studies between different teaching approaches would provide a broader understanding of their effectiveness and potential advantages.

DT has been defined by Professor Chedly Tabbane as "an educational situation, consisting of the organized meeting between a small group of students and a facilitating teacher for a defined educational purpose, proposed by the teacher and accepted by the group" (6).

The evaluation of this teaching method in our study was based on the structured reconstruction of a real observation known to the student, using a standardized form used at our institution (6). This form was adapted to the data found in patient records of individuals with genetic disorders and allows student to reconstruct the clinical reasoning that led to the diagnosis. The SSO allows for the development of recognizing an archetype or pattern, as well as teaching the hypothetico-deductive method, as hypothesis generation remains one of the components of the SSO. The SSO is a pedagogical approach used in a well known “Tell me the story Backward”. This method encourages learners to articulate their thought processes in reverse order, promoting deeper reflection on their diagnostic reasoning and decision-making (31).

The choice of pathologies studied in the DT was based on the objectives of the clinical rotation and the most frequently encountered genetic pathologies in pediatric services. This is a recommendation from our institution (6).

The learning method through SSO was generally appreciated by all participating students. They found the DT beneficial and well-organized. This result is consistent with the literature, which shows that students prefer active learning methods that involve solving real clinical cases rather than traditional methods based solely on

memorization (20).

The second level of Kirkpatrick's model (9), referred to as "knowledge/skills," allowed us to measure student learning through MCQs aligned with the learning objectives.

The SSO teaching method is recommended by our institution during clinical rotations (6) and can be used for both formative and summative assessment. In fact, the students' rotation grade included the average scores of the SSOs. The evaluation was both formative and sanctioning, due to the short duration of the genetics rotation.

To measure the effect of the teaching, we chose the pre- and post-test method, which is a quantitative approach that is quick and easy to administer. The comparison of the mean scores between the pre-tests and post-tests revealed a significant improvement ($p < 0.0001$). However, these results do not demonstrate the students' ability to contextualize their newly acquired knowledge when faced with a real patient or the long-term retention of knowledge. To address this limitation, a delayed post-test (beyond two months) could be administered to all students who participated in the study (21,22).

The mean scores of the pre-tests ranged from 7.45 to 11.57 out of 20, while those of the post-tests ranged from 11.58 to 14.15. Comparing these averages with those of another Tunisian study on the impact of the "Clarifications, Illustrations, Application, Participation" (CIAP) method reveals a significant difference (23). In the latter study, the scores were much lower, which was attributed to students' lack of preparation with the SLM before attending the CIAP session. Thus, we emphasize the importance of SLM preparation and the impact of the assigned grade. No question from the pre- and post-tests remained unanswered. In some cases, the score on the pre-test was higher than that on the post-test. This could indicate that students tended to guess when they didn't know the answer.

Since the SSO is a teaching method specific for CR to the FMT, there is limited literature on this educational tool. However, in a Tunisian study that examined the benefits of problem-based learning (PBL) and included 42 students, the RG was above 50% in 57% of cases, and Cohen's d was 0.9 (24). There is a difference between the results of that study and ours, which could be explained by the different pedagogical methods used. In the PBL study, the teaching method allowed the evaluation of problem-solving from an unknown case (24), unlike our method which is recommended at the beginning of the rotation when students are not yet trained to develop problem-solving skills in genetics from unknown cases.

The student satisfaction questionnaire can cover the entire teaching experience or a specific aspect of it. The questions should meet certain requirements such as clarity, affirmative wording, absence of double negatives, and a limited number of questions (25). The questionnaire used in our study met these writing criteria.

As for the response scale, we chose to use the Likert scale (8) instead of "yes" or "no" responses (25). However, we modified this scale by removing neutral and undecided responses. With this adaptation to a four-point scale ranging from -2 to +2, students were forced to take a position of "agreement" or "disagreement" and not resort to neutral responses (25).

In the majority of cases (81% to 95%), students were very satisfied with the organization of the teaching. Factors such as displaying the program on the first day of the rotation, adhering to the program, and providing a quiet space for tutorial sessions were essential elements for good teaching organization. In another thesis work that focused on tutorial sessions in genetics, the time (between one hour and a half and two hours) was considered long by nearly 23% of the students (26). To address this issue, extending the duration of the genetics rotation for MS4 and including the genetic pathologies studied in the third-year of medical studies would allow for shorter tutorial sessions, increased frequency, and diversified modes of transmission. All students found the slideshow clear and well-illustrated. During the plenary session, the clinical case was discussed step-by-step as the form for the SSO was corrected, using illustrated slides prepared based on the objectives and structure of the SSO form, following certain standards (27).

At the end of the three tutorial sessions, all students believed they had acquired new skills. This result is consistent with findings from Tunisian and international literature (23,28). All students agreed on the importance of tutorial sessions as an interactive teaching method compared to lectures.

Conclusion

Medical education encompasses both theoretical and practical aspects. Clinical rotations are just as essential as theoretical courses for acquiring and solidifying new knowledge. The success of a clinical rotation is contingent upon meticulous organization and planning that define the objectives to be achieved. Teachers should strive to enhance their teaching by ensuring meaningful learning experiences for their students. They should employ various methods to make the teaching more engaging and motivating. Thus, our work has demonstrated the value of tutorial sessions on genetic diseases in acquiring new knowledge and developing clinical reasoning skills among MS4 using the SSO approach. However, reading the SLM before attending the tutorial session is necessary for better assimilation of the knowledge.

Abreviations
CR: clinical reasoning
DT: directed teaching
FMT: faculty of medicine of Tunis
MCQ: multiple-choice questions
MS4: forth-year medical student
PBL : problem-based learning
RG: relative gain
SLM: self-learning module
SSO: structured summary of observation

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