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Submission date: 26-Apr-2022 02:58PM (UTC+0200)
Submission ID: 1820842934
File name: 1-Cammeo_68765_1298419216.docx (113.51K)
Word count: 6987
Character count: 40212

CERIP
University of Messina

ISSN 2612-4033

Journal of Clinical & Developmental Psychology

Journal homepage: http://cab.unime.it/journals/index.php/JCDP/index

Teaching clinical reasoning to psychology students: an exploratory study on the potential of a podcast training

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ABSTRACT

Background: Clinical reasoning is a construct shared by all health professions, which, starting from a problem or a series of symptoms, through the recounting of useful information, arrive at a diagnostic and treatment hypothesis. This paper aims to reflect on the possibility of including the teaching of clinical reasoning within the curricula of psychologists in training, even more so in light of the approval of the law on qualifying degrees.
Method: A quasi-experiment was conducted between a group of psychology students exposed to clinical reasoning through a podcast training and another group of students who used a more traditional methodology of studying a script.
Results: The findings revealed an improvement in the acquisition of clinical reasoning by the group of students exposed to podcast training in contrast to their colleagues who had studied written materials.
Conclusions: The clinical reasoning assessment tool developed in the study could become a very functional tool for assessing the improvement of this skill in future clinical psychologists, even with the benefit of more sophisticated virtual reality technologies for the design of podcasts that would allow for a more immersive and realistic experience.

Keywords: *Clinical reasoning; Critical Thinking; Problem Solving; Psychology; Podcast; Online*

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https://doi.org/10.13129/2612-4033/0110-3394

Accepted Online first: 2022

Introduction

Clinical reasoning is one of those professional skills that are extremely complex to learn and, paradoxically, once acquired it is not easy to explain when and how it is used. It is conceptualized as the process by which health professionals generate clinical judgements by choosing between alternatives, and weighing evidence. It is using intuition and pattern recognition, gathering clues, processing information, coming to an understanding of a patient or situation problem, planning and implementing interventions, evaluating outcomes, and reflecting on the process (Payan-Carreira et al., 2019; Koufidis et al., 2020; Robertson, 2012; Faucher, 2011). It thus results as an intellectual activity belonging to all professions that, through the collection and analysis of a range of information, come to identify the problems that are the object of interest (Kosior, Wall & Ferrero, 2019; Young et al., 2019). In psychology, this process, starting from a health problem, an attitude, behaviour or thought, passing through the medical condition, the anamnesis and the history of the individual, leads to the formation of one or more diagnostic hypotheses. A large part of psychological know-how consists of intangible aspects such as: clinical reasoning, critical thinking and judgement, problem solving, which in clinical practice guide the psychologist in diagnostic and intervention choices (Norman, 2000).

There are many studies and reviews that address the most functional ways of explicitly teaching clinical reasoning skills in the traditional health care setting (Abrami et al., 2008; Mason et al., 2020; Richmond et al., 2020; Pramila-Savukoski et al., 2019; Delany et al., 2020). Indeed, in recent decades, the acquisition of clinical reasoning and critical thinking skills (particularly for physicians, dentists, nurses, neuropsychomotor therapists and speech therapists) has once again become an interest of higher education institutions (Choi et al., 2020; Mutter et al., 2020; Ihm, Shin & Seo, 2020; Pierce et al., 2020; Robertson, 2012). Such interest and studies have turned to the analysis of teaching practices that can transfer skills useful for facilitating the transition of recent graduates to the world of work (Vidyarthi et al., 2016; Young et al., 2020). In healthcare, reducing the gap between theory and practice could facilitate the inclusion of new graduates in work teams and ensure continuity in the quality of care provided to patients (Durning, Trowbridge & Lambert, 2019). While these considerations are valid in the medical field (doctors and nurses) and in all historically health professions (speech therapists, occupational therapists, physiotherapists), the literature on teaching critical thinking to psychology students, is poor (Karatzas et al., 2013; Bensley et al., 2010; Muehlenkamp et al., 2015; 2007; Solon, 2006; Campbell & Oswald, 2018; Wentworth & Whitmarsh, 2017). The results of these works, although in different ways, suggest that learning strategies that actively involve students (trough cooperative leaning, small group activities, interactive workshops

and discussions) may be preferable to traditional classes to promote critical thinking and clinical reasoning. However, the presence of a limited number of studies associated with the lack of a solid theoretical background and the diversity of evaluation tools compromise the comparison of the effectiveness of the learning activities described.

This paper is intended to be a basis for designing a research project aimed at investigating the impact of the different methodologies, as well as a starting point to solicit a reflection on the possibility of including the teaching of clinical reasoning in the different levels of training dedicated to psychologists. Generally, the contributions examined highlight that a holistic approach that integrates online methodologies and tools into face-to-face teaching is the most protective factor, even in the event of possible future unexpected restrictions (Mseleku, 2020; Wilcha, 2020). Several studies suggest that virtual teaching is effective and, based on them, institutions are working to further develop these resources in order to improve student engagement and interactivity (Flores & Gago, 2020; Wargadinata, Maimunah, Eva, & Rofiq, 2020; Wilcha, 2020). In this regard, a number of experimental studies have been considered in which podcasts are used as a tool to enhance teaching and learning experience in university students (Evans, 2008; Kurtz, Fenwick, & Ellsworth, 2007; Lazzari, 2009; Mcgarr, 2009). Indeed, in the last decade an increasing number of universities, colleges, and other institutions have begun to introduce this technology as a learning tool (Mcgarr 2009). The popularity of podcasting in education has been accompanied by positive results provided by several studies (Kurtz, Fenwick and Ellsworth, 2007; Lazzari, 2009), which oriented the choice of using this online teaching methodology in the present work.

Given this, the present work is intended to be an exploratory study, which through a quasi-experiment aims to investigate the potential of a podcast course for promoting clinical reasoning in university psychology students, compared to a more traditional methodology of studying a script in which clinical reasoning is described. In particular, it is expected that students who attended the course and listened to podcasts would receive higher scores on the post-test than the control group, who did not listen to podcasts but studied only from traditional written materials. Agreements and disagreements between examiners will also be investigated, in order to make the results as objective as possible.

Compared to the existing literature, its innovative character is the development of podcasts based on real clinical cases, which can offer a very realistic experience to students.

Method

Participants

The academic year 2020/21 was characterised by a blended learning, in which students were able to choose between attending classes in person or streaming online. At the time of the study, which ended

before the second Italian lockdown, participating students chose to attend the course in person. Ninety-two students (79 women and 13 men), all Italian as first language, enrolled in the academic year 2020/21 in the Master's Degree Course in Psychology of Clinical and Social Intervention at the University of Parma, participated in the study. Of the 92 students, 73 were attending (63 females and 10 males with an average age of 25 years) and 19 were not attending students (16 females and 3 males with an average age of 29 years), i.e. Students following the course only in telematic mode, and therefore not accessing the university classroom in person. All students involved completed both the pre-test and the post-test. The students also followed the course "Assessment and Intervention on DSA", a characteristic teaching of the second year of the Master's Degree Course in Psychology of Clinical and Social Intervention (scientific disciplinary field of Developmental and Educational Psychology).

During the first lesson of the course attended by 84 students (attending and not attending), students were presented with the opportunity to participate in the study, fully describing the aims and objectives and making it clear that participation in the study would in no way influence the final assessment. Informed consents signed by the students were delivered, collected, and kept, and the opportunity to provide any further information was offered to anyone who requested it: 84 students signed the informed consent. The 24 students absent at the first lesson, but enrolled in the second year of the degree course, were sent an email, to which 8 responded, sending the signed informed consent; finally, the remaining 16 students did not respond or refused.

Procedure and Measures

The research is configured as a quasi-experiment in which a pre-test and a post-test were carried out on both groups of attending and non-attending students, with the aim of exploring the effects of the training on the group of attending students. Before the administration of the pre-test, in order to make all students homogeneous concerning the knowledge of the diagnostic criteria of the different neurodevelopmental disorders as identified in the DSM-V, 60 flashcards containing the diagnostic criteria of the neurodevelopmental disorders taken into consideration were used. These flashcards regarded: Language Disorder, Phonetic-phonological disorder, Fluency disorder with onset in childhood, Pragmatic communication disorder, Autism spectrum disorder, Attention deficit hyperactivity disorder, Specific learning disorder, Motor coordination disorder, stereotyped movement disorder, ICT disorder. The prerequisite for participating in the study and taking the Course exam was the achievement of 100% accuracy on the test by the start date of the experiment; all participants achieved the criterion before the post-test. Non-attending students also did the online exercises on flashcards, as this mode and the brevity of the sessions meant that there were no obstacles

to work or family life. Pre-test and post-test for attending students took place live during 2 lessons (29 October 2019 to 26 November 2020). The conduct of the tests did not require additional time as the same was proposed to all students as an exercise integral part of the course. For non-attending students, the pre-test was carried out online on the Microsoft Teams platform on 29 October 2019, at two different times (from 12 to 1 pm and from 7 to 8 pm) to allow all 19 students to participate; the post-test, on the other hand, was carried out for each participant on the date of the fixed oral examination, 20 January 2021 for 10 students and 17 February 2021 for 9 students. Both the pre-test and post-test for attending and non-attending students lasted 45 minutes. For the group of attending students, the study lasted two months for a total of 12 lessons of 3 hours each: the first lesson in which the pre-test was carried out, the following lessons in which the 10 podcasts were listened to and the final lesson in which the post-test was carried out. In each lesson the duration of the podcast listening activity was about 1 hour; after listening to the podcast the teacher left a space for questions and doubts of the students on clinical reasoning. The non-attending group did not have access to the podcasts. Both attending and non-attending students studied the text "Diagnosis of developmental disorders: Models, diagnostic criteria and clinical cases" by Vio and Lo Presti from 2014, which was provided for the exam.

Pre-test and post-test Materials. For the purposes of the present study, 40 tracks of the third proof (clinical case) of the State Examination for the qualification to the profession of psychologist were selected. The tracks were selected from those drawn from 2015 to 2019 in the Universities of Bologna, Milano Bicocca, Florence, and Padua and concerned clinical cases of minors with psychopathologies or psychological difficulties faced during the course (DSA, Autism, Intellectual Disability, ADHD, DOP, school difficulties, anxiety, depression). The text described the case of a minor and the student, on the basis of the data described, elaborated a justified differential diagnosis, proposed an evaluation and hypothesized an intervention. Each student had 45 minutes to complete the tests and received one pre-test and one post-test track randomly selected by the teacher. Each student was given an A4 sheet of paper on which to complete the test either freehand or on the computer. Each student was given a code in order to make him or her anonymous. Moreover, to avoid possible conditioning, codes were associated with all the tests, st it was not possible to understand the pre-test or post-test nature during the scoring phase.

Pre-test and post-test assessment methods. The tests were assessed using the scheme proposed by Daniel et al. (2019). Based on different theories, the authors identify 7 components of clinical reasoning: information gathering, hypothesis generation, problem representation, differential diagnosis, functional diagnosis, treatment, and diagnostic justification. Of the 7 components

presented by the authors, 3 categories were considered assessable and each test was evaluated considering the categories presented below.

1. *Information gathering*: The authors define the category "information gathering" as the process of acquiring data necessary to generate or refine hypotheses (Daniel et al., 2019; Gruppen et al., 1991; Schmidt & Mamede, 2015). Usually, this active process includes history and textural data acquisition, but can also be implicit (through observation). The selection of information to be collected is guided by knowledge of the characteristics of the disorder (for example script, schema) (Daniel et al., 2019). For the purposes of this study, the category of information gathering included any additional information, consistent with the clinical case, which the student would request in a possible second meeting with the clinical subject or family members. Assertions in which the student asked for information that was too general (for example "I would take a more complete anamnesis") or inconsistent with the clinical case ("in a child with separation anxiety, an in-depth examination of the IQ") were not considered as collection of information.

2. *Hypothesis generation*: it is defined as an early process by which the psychologist tries to find disorders or diagnostic categories that can explain the patient's clinical findings (Daniel et al., 2019; Krupat et al., 2017; Pelaccia et al., 2015). Hypothesis generation involves the activation of problem knowledge representations in an interactive process that feeds into information gathering (hypothesis generation leads to more information gathering, which in turn leads to more hypothesis generation and/or refinement of hypotheses) (Daniel et al., 2019). For this study, statements in which the student presented a symptom in relation to a disorder and this relationship was consistent with the clinical case (for example "if the child does not remain seated, I hypothesize the presence of an attention disorder") were considered in the hypothesis generation category. Statements in which the presence of a characteristic excluded a diagnosis were also considered ("he has very good social relationships with peers so I feel I can exclude autism"). If more than one symptom was linked ("he writes badly and reads slowly so I assume a learning disorder") two separate statements were considered, as both symptoms were, even separately, considered symptomatic. Hypotheses in which the symptom was in no way linked to the disorder (for example "flickering hands, I hypothesize depression") or there was no scientific basis for the relationship between symptom and disorder ("the mother is single, probably the child does not speak for this reason") were not considered.

3. *Management and treatment*: included within this category are hypothesized actions that follow the clinical reasoning process, including prognosis, management, treatment, prevention strategies (including improving quality of life), and justification for treatment choices (Daniel et al., 2019; Goldszmidt et al., 2013; Stojan et al., 2017). In the present study, statements in which the student presented a type of intervention consistent with the disorder were considered in the category of

management and treatment (in case two treatments were identified e.g., teacher and parent intervention were considered separately).

The categories *differential diagnosis* and *problem representation* were excluded for the purposes of this work. The reason for this exclusion is linked to the type of assessment instrument used. The written clinical case did not allow the student the possible examination of a differential diagnosis through the use of tests or subsequent observations, therefore the statements concerning possible hypothetical differential diagnoses, not being able to be tested, were considered in the category generation of hypotheses. The category *problem representation* was excluded because it would have provided for a conceptualization of the clinical case which is beyond the educational objectives of the Degree Course and is usually an objective of specialization schools. It has been defined by Daniel and collaborators (2019) as a dynamic mental representation of all the relevant aspects of the case (including the patient's clinical findings, bio-psycho-social dimensions, etc.) to be communicated in a summary (by means of qualifiers and semantic keys).

Scoring. Three postgraduate psychology trainees were formed to carry out the scoring of the tests. The complexity of the scoring methods required an ad hoc preparation. It included an independent study of the categories presented above and a practical training of 10 hours divided into 5 meetings of 2 hours in which, with the first author of the study, the trainees analyzed 10 tests not included in the study. In the scoring phase, after anonymizing the tests, the 3 trainees independently rated each test by attributing to each category (information gathering, hypothesis generation, and treatment management) a score equivalent to the number of corresponding statements. The tests were written either freehand or on the computer and were made available online or photocopied to provide each trainee with a copy. Each trainee independently underlined the sentence with a different colour according to the category to which they attributed the statement. At the end of the correction of each test, the scores of each category were compared and, in case of non-concordance, the average score was calculated and entered. To analyze the dissemination potential of this clinical reasoning measurement system and to allow for greater contextualization of the limitations, the study included an analysis of the percentage of agreements and disagreements in the different categories of the 3 trainees trained.

The podcasts. For this research 10 podcasts, all in Italian language, were structured. They were based on 10 different clinical cases, in particular: 3 cases of specific learning disorders (1 female aged 7 years, 1 male aged 8 years, 1 female aged 13 years); 2 cases of autism (1 male 3 years old, 1 female 12 years old); 1 case of language disorder (1 female aged 3); 2 cases of intellectual disability (1 male aged 5, 1 female aged 14); 2 cases of ADHD (1 male aged 8, 1 female aged 9).

The podcasts, all related to the first interview with the family, were organized on the basis of the guidelines for the diagnosis of developmental disorders presented by Vio and Lo Presti (2014). The authors present the clinician with linear and systematic diagnostic pathways for developmental age, anamnestic cards and suggestions for clinical reasoning (Vio & Lo Presti, 2014).

Each podcast had a duration of 45 minutes. There was a first phase of presentation of the problem by one or both parents, alternating with questions by the clinician on missing anamnestic elements or relevant information not presented by the parents. The second part was aimed at the clinician's reasoning based on the elements that emerged during the interview, specifically: any additional information/test/observation to be prepared/arranged; generation of hypotheses on the basis of the elements emerged, diagnostic and differential hypotheses; hypotheses regarding treatment or the need for involvement of other specialists.

The scripts of the audio material were written by the first author of the present study, the realization of the podcasts was carried out by a company of actors, and the editing by a company specialized in dubbing and voice-over.

The textbook. The course provided for attending and non-attending students the study of the same textbook "Diagnosis of developmental disorders: Models, diagnostic criteria and clinical cases'" by Vio and Lo Presti (2014). The book was chosen because it is focused on directing clinicians and students to a clinical reasoning based on linear and systematic diagnostic paths for the developmental age and, in particular, for neurodevelopmental disorders. The text, starting from the request for consultancy, according to the methodological stages of scientific research, guides the reader through the collection of precise anamnestic information, the formulation and subsequent verification/reduction of diagnostic hypotheses up to the interview, clinical observation and the administration of instrumental tests leading to the elaboration of the diagnosis. The text is full of written clinical cases that the student can read to imagine and immerse himself in the situation.

Results

Statistics and data analysis

The data for this study were analyzed using SPSS version 26 software. The distribution of many variables was found to be non-normal. In view of this, univariate analyses were conducted using non-parametric tests (Wilcoxon test for paired samples and the Mann-Whitney U test), as appropriate. The results are presented at a significance level of p-value < .05. The non-parametric analysis carried out within each group between the two different surveys (pre-test and post-test) of each category shows some significant differences between the scores.

The group of attending students shows a statistically significant difference in scores for all three pairs of variables (categories). Specifically, there are different mean values between pre-test and post-test in information gathering (Wilcoxon test; Z = -6.762, p < .001, r = -0.80), pre-test and post-test in hypothesis generation (Z = -6.408, p < .001, r = -0.75) and pre-test and post-test in management and treatment (Z = -6.739, p < .001, r = -0.79). Table 1 show an increase in mean scores between the first and second survey (mean table).

	Pre-test				***Post-test***			
Attending students (N=19)	Min	Max	*M*	SD	Min	Max	*M*	SD
Information gathering	0	8	1.21	1.932	1	5	2.95	1.311
Hypothesis generation	0	4	1.79	1.182	1	5	2.79	1.032
Management and treatment	0	5	2.32	1.493	1	6	3.58	1.261
Non-attending group (N=73)	Min	Max	*M*	SD	Min	Max	*M*	SD
Information gathering	0	8	0.71	1.349	0	16	5.29	3.799
Hypothesis generation	0	8	1.58	2.198	0	19	6.74	4.429
Management and treatment	0	7	2.58	1.825	0	12	5.90	2.450

Table 1. Descriptive statistics for attending students and for not-attending group

The average scores between the pairs of variables in the group of non-attending students are also all significantly different. In particular, the pre-test and post-test scores of information gathering (Wilcoxon test; Z = -2.935, p = .003, r = -0.67), hypothesis formulation (Z = -2.423, p = .015, r = -0.56) and management and treatment (Z = -2.369, p = .018, r = -0.54) show a difference. Similarly, the increase in scores reported between pre-test and post-test is shown in Table 1.

Table 2 presents for all trainee pairs (trainee A, B and C) the number of total agreements and disagreements.

		Agreements	Disagreements
Information gathering	A-B	71	22
	A-C	82	11
	B-C	85	8
Hypothesis generation	A-B	69	24
	A-C	87	6
	B-C	76	16
Management and treatment	A-B	88	5
	A-C	86	7
	B-C	91	2
Total		735	101

Table 2. Agreements and disagreements between experimenters

Comparison between the group of attending and non-attending students in the various corresponding variables reveals significant differences between the scores in the post-test categories. In particular, there are significantly different mean values between the two groups in post-test information research (Mann-Whitney U test; U = 413, p = .007, r = -0.28), post-test hypothesis formulation (U = 246, p <

.001, r = -0.45) and post-test management and treatment (U = 267, p <. 001, r = -0.43). With regard to the scoring and scoring methods for the pre-test and post-test, a range of disagreement between ±2 was found with a prevalence of disagreements having difference 1. An equal score that two trainees attributed to a category was considered agreement and disagreement those situations in which different scores were attributed.

Discussion

In relation to the attention that the national literature is placing on the need to find tools to evaluate clinical reasoning (Notarnicola et al., 2020), it is appropriate to present a commentary on the results. The group of attending students shows a statistically significant difference in the scores for all three pairs of variables. Specifically, there are different mean values between pre-test and post-test in information gathering, pre-test and post-test in hypothesis generation and pre-test and post-test in management and treatment. However, the mean scores between the pairs of variables in the group of non-attending students were also all significantly different. Both study and teaching methods ("textbook" versus "textbook and podcast") seem to significantly improve the clinical reasoning ability of the students who participated in the study. However, there is a very relevant fact, that students who also listened to podcasts improved to a greater extent. The comparison between the group of attending and non-attending students in the various corresponding variables revealed significant differences between the scores of the post-test categories. This improvement in the group of students who also used podcasts, compared to the alternative group who only used the textbook, is a decidedly relevant result, in light of the national and international literature that unanimously emphasizes the importance of clinical reasoning in the health professions (Dissanayake, Colicchio, & Cimino, 2020; Lee et al., 2021). Finding effective educational methodologies that enhance the acquisition of this skill is also crucial in relation to the current regulatory context that eliminates the professionalizing internship and returns an important educational role in clinical skills to the university.

The secondary purpose of the work was therefore to evaluate the level of agreement and disagreement in the attribution of scores in the pre-test and post-test. The number of agreements versus disagreements seems to suggest a good reliability of the categories as defined in the study, although there appears to be a strong difference in favour of the category "management and treatment". The categories "information gathering" and "hypothesis generation" have a higher number of disagreements than the category "management and treatment". Likely, the greater agreement is mainly due to the vagueness and non-specificity of the terms delineating psychological treatments. Indeed, by their nature, in the current state of clinical research, psychological/psycho-educational treatments are not as specific as some health treatments. Most prognoses of developmental disorders

involve psycho-educational treatments involving parents, children and teachers. In the present study, no specific protocols were associated with the disorders: in subsequent studies, a higher number of disagreements may emerge if greater precision is required in identifying specific treatments. The categories "information gathering" and "generation of hypotheses" show a percentage of agreement that is around 82%: this means that on a single test two independent trained observers share and correctly label 8 out of 10 information or 8 hypotheses. This appears to be extremely positive as it suggests that, despite the great variability of the material (40 different trials), the categories appear to be sufficiently descriptive and inclusive. Despite the complexity of scoring, achieving a high percentage of agreement suggests that the instrument can be used to assess how well the individual student is able to 'reason clinically', offering parameters for discussion and personal growth that are difficult to achieve with other clinical reasoning assessment instruments. In fact, it may be very complex for the student to understand "where he/she went wrong in thinking" if the evaluation of clinical reasoning is done through questionnaires/tests or general judgments. The scoring mode created with this study, which can clearly be improved, provides teachers and traineeship tutors with an assessment mode that not only allows them to understand the reasoning mode, but also offers the possibility to give specific feedback to the student. A scoring mode like the one presented, in fact, could be used at the end of a curricular traineeship course or as a selection procedure at a job interview to offer an assessment that does not contain only elements of knowledge but also evaluations of the psychologist's know-how. If it is true that a modality of this type seems to function as a potential tool for evaluating the clinical reasoning of a psychologist, in a perspective of contraction of the resources of the health system, it also makes sense to think about the economic and social sustainability of the scoring modality presented. This modality provides for a training phase consisting of a period of independent study of the categories and a practical training of 10 hours divided into 5 meetings of 2 hours in which, with a person expert in the instrument, 10 tests are analyzed. This kind of training is quite long (about 12 hours for the trainee and 10 for the tutor). However, considering an A.U.S.L. company or a big cooperative, it could be reasonable to plan a training involving all the trainees' tutors in order to standardise the assessment procedures for incoming and outgoing trainees. In this case, the cost would certainly appear more sustainable. In the case of smaller organizations (such as freelancers or associated firms) it might make sense, through new research, to consider how to make training less expensive, including through the use of augmented intelligence systems. The anecdotal data collected from the trainees involved in the scoring work opens the door to further discussion on the sustainability of the tool and its potential usability in clinical settings (e.g., facilities hosting curricular trainees). The trainees involved generally described the scoring mode as understandable, fairly applicable and, independently, stressed the need to receive initial training that would allow a

clear understanding of the category "hypothesis generation" which appeared, in most cases, the most complex.

Conclusion

The study presented, although not free from important limitations, allows to make reflections able to guide scholars in the design of research that will deepen and enrich the literature on the teaching of clinical reasoning in the psychological area. The podcast seems to be an adaptable and usable technology within university classrooms: in fact, no particular technological equipment is required and the structure of the classroom (podcasts were tested in 6 different classrooms of the Didactic Pole of the University of Parma) does not seem to significantly influence the students' audio experience. The easy adaptability and usability of the technologies result to be significant data, if we consider the different technological equipment of the different Universities. The cost of making 10 podcasts is about 10,000 euros including recording and audio editing and the presence of at least 3 actors per category (3 psychologist voices, 3 mother voices, 3 father voices); in comparison, the cost of making video clips of the same length is much higher (about 100,000 euros). The clinical reasoning assessment tool developed in the study could become a very functional tool to assess the improvement of this ability in future clinical psychologists. This evaluation method could be used both by university teachers and by traineeship tutors in affiliated contexts.

Limit of the research and future prospective

The research has several limitations, first its methodological nature: it is in fact a quasi-experiment as the control sample, composed of non-attending students, could present differences that could potentially have influenced the study. For example, the motivation for which the students did not attend the course was not detected: some of them could have been placed in professional contexts capable of affecting their competence. Moreover, in addition to listening to podcasts, many other variables linked to course attendance (active student participation, involvement, etc.) could explain part of the more significant improvement achieved by the attending students. Considering also that for obvious educational reasons it was not possible to have a group without the textbook and only the podcast, it is difficult to assess if the changes in the post-test are due to the podcast or the textbook. Another limitation is related to the tool itself. As shown in table 2 on agreements and disagreements, it does not represent an objective way of assessing clinical reasoning, but a first approach to develop a way of assessment that can be used in clinical contexts. Finally, these results are preliminary and the present work does not claim to be generalizable in any way.

Future research could investigate the effects of a podcast training with audio-spatial technology, which would allow the acquisition of clinical reasoning through even more realistic simulation

experiences of the clinical interview. Podcasts would be recorded involving experienced professional voice actors integrating new virtual reality and augmented reality technologies (Oculus Rift, HTC Vive, PlayStation VR, Microsoft Hololens). The use of "audio-spatial" technologies would make it possible to recreate not only the sound and timbre qualities of the acoustic scene under consideration, but also its spatial properties (position and orientation of the acoustic sources, shape and characteristics of the environment, etc.). The addition of space in this listening mode allows to evoke the impression of being "present" in the acoustic scene being reproduced, which means "immersed" and "active". This is therefore a huge 'quantum leap' in acoustic rendering technology, because, in addition to the realism and accuracy of spatial reproduction, it also requires introducing the possibility of interacting with the acoustics of the reproduced scene. It could be tried to create in a virtual environment a simulation of the first clinical interview and to evaluate the potential of an immersed environment in promoting clinical reasoning.

Declaration of Interest statement: None.

Authors' contribution

Catia Cammeo assisted with concept, study design, manuscript preparation and manuscript editing; Giulia Prestera assisted with data analysis, manuscript preparation and manuscript editing; Francesca Cavallini assisted with the generation of the initial draft of the whole manuscript, data analysis and interpretation; Davide Massaro and Antonella Marchetti assisted with study supervision. All authors contributed to and have approved the final manuscript.

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