

ORIGINAL RESEARCH PAPER

## **Learning Strategies used by Cardiology Residents: Assessment of Learning Styles and their Correlations**

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**ABSTRACT Objective:** *To identify the learning styles of a group of cardiology residents (R) undergoing a training program at the University of Buenos Aires and to identify correlations of these styles.*

**Methods:** *Statistical data were obtained through a 120-question survey developed by Vermunt and colleagues, which identified four different learning styles: construction-directed; reproduction-directed; application-directed; and undirected. Four variables were identified [gender, previous experience as a teaching assistant (TA) in medical school, university final average (FA) and the public or private institution/centre of origin] in order to analyse level of correlation with learning styles (LS). Between April 2001 and April 2002, 149 residents (R) completed the survey. Average age was 29 ( $\pm 2.7$ ) years old; with 63% being men.*

**Findings:** *The predominant LS were oriented toward knowledge application. In terms of variables, no differences regarding gender were detected; the R with TA showed undirected LS characteristics; those with a low FA registered a tendency towards reproduction-directed LS; and those residents at public/state medical centres indicated construction-directed LS tendencies.*

**Conclusion:** *An application-directed learning style predominates in this group of residents. Information regarding learning styles can provide foundations upon which arguments can be made for changes in education that are traditionally not evidence-based.*

**KEYWORDS** *Learning styles, residents, post-graduate, Vermunt's inventory of learning styles.*

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## Introduction

In recent years, educational studies have indicated that students possess different learning styles. Relatively stable characteristics of student behaviour, within the learning process, are referred to as “Learning Styles”. It is thus possible to identify four different learning styles: construction-directed, application-directed, reproduction-directed, and undirected (Vermunt, 1996 – see Table 1):

- *Construction-directed Learning Style*: the student attempts to discover connections within the assigned material, develop a critical opinion, and an integral comprehension, in order to best understand the material;
- *Application-directed Learning Style*: the student seeks concrete ways to apply the information he or she is studying;
- *Reproduction-directed Learning Style*: the student studies the assigned material in detail, attempting to memorize content in order to reproduce it for an exam;
- *Undirected Learning Style*: the student has not developed a clear strategy and utilizes secondary school study habits that are not suitable for university level.

The styles described above have four characteristics that differentiate them from one another: cognitive processes; reflective processes; learning orientation; and mental models.

- *Cognitive Processes*: learning activities that students use to process study material (relating, analysing). These can be concrete, deep, stepwise, or have hardly any processing. In the concrete model, the student connects the material learned with his or her own experience and applies it. In the deep model, he or she seeks to integrate new knowledge with that already assimilated, using a critical eye to arrive at his or her own conclusions. The stepwise model relies essentially on memory; additional analysis takes place through a process of grouping disjointed elements from lesser to greater complexities.
- *Regulation or Metacognitive Processes*: learning linked to emotional or cognitive processes (introspection, orientation). These can be self-guided, external through professors or books, or may not have any reflective process at all.
- *Learning Orientations*: the students’ goals, or motivation that drives their pursuit of studies. This may be defined by a sense of vocation, personal interest, a search for certification, self-evaluation, or may be ambivalent. The term “vocation” refers to the acquisition of professional skills in order to obtain employment. A personal interest orientation represents a desire for personal growth. Self-evaluation would include those students who study

**Table 1.** Learning styles and associated components

Components	Style			
	Construction directed	Application directed	Reproduction directed	Undirected
Cognitive process	Deep processing	Concrete processing	Step-wise processing	Almost no processing
Regulation of learning	Mostly self-regulation	Both external and self-regulation	Mostly external regulation	Lack of regulation
Learning orientations	Person-oriented	Vocational-oriented	Certificate and self-test oriented	Ambivalent
Mental models	Construction of knowledge	Use of knowledge	Intake of knowledge	Cooperation and being stimulated

to demonstrate their capabilities to themselves and others. An ambivalent orientation would reflect an unclear or undefined attitude relative to the student's own capacity.

- *Mental Models*: these constitute the group of concepts a student has regarding his or her own learning process, defining it, and to which ends his or her thought processes serve. These can be used for cooperation and stimulation, for incorporating new information, for construction, for use of knowledge. Knowledge of the distinct learning styles can be useful, as it affords objective, or evidence-based data to assist the professor in guiding his or her educational practice.

The aim of this study therefore, is to understand the ways in which cardiology residents confront their studies, and assess their individual perception of their learning process. Moreover, this study sets out to identify existing variables in order to analyse possible correlations that these have with the defined learning styles.

## Methods

An observational and cross-sectional study was carried out based on a survey of cardiology residents undertaking their training program at the University of Buenos Aires. The survey was developed by Vermunt and colleagues at the University of Tilburg in Holland. The Vermunt Inventory of Learning Styles integrates four learning components: processing strategies, regulation strategies, mental models of learning, and learning orientations. Using explanatory factor analysis, Vermunt identified four different learning styles: meaning-directed, application-directed, reproduction-directed, and undirected which displayed characteristic patterns of loading across the four components. The inventory consists of 120 items defining learning styles. Students were asked to indicate to what extent they implement each item/strategy in their studies. For each question, they answered using a Likert Scale of 1 to 5, 1 = strongly disagree and 5 = strongly agree (Vermunt, 1996). The survey was handed out to each resident at the offices of the Argentine Cardiology Society, with instructions on how to complete the questionnaire. Respondents were allowed to complete the survey at home, and return it to the offices of the Argentine Cardiology Society.

Of the total 120 questions, 27 are designed to define characteristics of cognitive processes (deep, stepwise, or concrete), 28 deal with regulation methods (self-regulated, externally regulated, or unregulated), 25 are focused on learning orientations (vocational, personal orientation, self-evaluation, or ambivalent), and 40 are meant to define mental models of learning (intake of knowledge, use, construction of knowledge, stimulation, and cooperation).

*Sample question designed to identify cognitive process strategies:*

Question #2: "I repeat the principle areas of the study topic until I know them by memory."

*Sample question designed to identify self-regulated strategies:*

Question #24: "When I begin to read a new chapter or article, I first analyse the best way to study it."

*Sample question designed to identify learning orientations:*

Question #65: "I carry out my studies based on my interest in the topics being covered."

*Sample question designed to identify mental models:*

Question #104: "To assess my own learning progress, I should try to respond to self-formulated questions about a given topic or subject."

An analysis of the group's learning styles was carried out. Four variables were identified: gender, previous experience as a teaching assistant (TA) in medical school, university final average (FA), and the public or private institution/centre of origin. These variables were then analysed to determine the influence they might exercise on learning styles. The analysis of the medical school medical average was undertaken by dividing students into two groups based upon the mean: G1;  $GPA < \text{mean}$  and G2  $\geq \text{mean}$ .

The quantitative data are expressed as mean  $\pm$  one standard deviation. The quantitative variables were analysed using the Mann Whitney test (non-parametric). A value of  $p < 0.05$  was considered statistically significant.

To estimate the instrument's reliability, the Cronbach measure (Alpha) was utilized ( $\alpha$  coefficient), correlating each question with that of its own dominion (SPSS Version 8).

## Findings

The study was carried out from April 2001 to April 2002; 149 (92%) of 161 residents answered the questionnaire. The group's mean age was 28.9 ( $\pm 2.6$ ) years old; 63% were male. Of the total residents surveyed, 51% were located in private medical centres. The FA was 7.76 ( $\pm 0.88$ ). Fifty-three percent of the residents had previous experience as teaching assistants during their medical school training.

### *Global Analysis*

Table 2 presents results that differentiate the learning styles. In terms of cognitive process strategies, a predominance of concrete strategies ( $4.05 \pm 0.65$ ) and deep-level thought ( $3.56 \pm 0.85$ ) was demonstrated in the cardiology residents' responses. Related to learning regulation strategies, there was a predominance of the use of self-regulated strategies ( $3.38 \pm 0.59$ ). With respect to learning orientations, vocational ( $4.47 \pm 0.50$ ) and personal interest

**Table 2.** Reported learning styles of cardiology residents

	Items	Alpha <sup>1</sup>	Mean	SD <sup>1</sup>
<i>Cognitive Processes</i>				
Concrete	5	0.67	4.05	0.65
Deep	11	0.85	3.56	0.85
Step-wise	11	0.71	2.56	0.55
<i>Regulation Strategies</i>				
Self	11	0.76	3.38	0.59
External	11	0.65	2.88	0.52
No regulation	6	0.48	2.25	0.57
<i>Learning Orientations</i>				
Vocational	5	0.68	4.47	0.50
Personal Interest	5	0.51	3.38	0.54
Certification	5	0.22	2.67	0.48
Self-evaluation	5	0.81	2.49	0.99
Ambivalent	5	0.67	1.95	0.68
<i>Mental Models</i>				
Use	6	0.47	4.28	0.45
Construction	9	0.63	4.05	0.41
Stimulation	8	0.72	3.73	0.56
Cooperation	8	0.76	3.33	0.65
Incorporation	9	0.63	2.80	0.53

<sup>1</sup>Cronbach's Alpha Coefficient, SD: Standard Deviation.

( $3.88 \pm 0.54$ ) orientations were most dominant. Finally, in terms of mental models, use ( $4.28 \pm 0.45$ ) and construction of learning ( $4.05 \pm 0.41$ ) stood out as models used most often by the residents. In relation to possible correlations of learning styles, there were no significant differences in the cognitive processes, self-regulation strategies, learning orientations, or mental models with respect to gender. On the other hand, students with experience as teaching assistants demonstrated a tendency towards mental models of stimulation (3.93 vs. 3.67,  $p = 0.003$ ).

Additionally, students with an FA less than the mean showed learning orientations directed towards certification:  $G1 = 2.78$  vs.  $G2 = 2.54$ ,  $p = 0.01$ . Finally, students of public medical centres demonstrated learning styles oriented towards personal interest (public = 4.03 vs. private = 3.83,  $p = 0.03$ ) and self-evaluation (public = 2.73 vs. private = 2.34,  $p = 0.01$ ).

## Discussion

The aim of this study was to identify the learning styles of a group of cardiology residents, and to determine correlations with other variables related to learning styles.

Results show that: concrete thought is predominant in cognitive processes; in regulation strategies, self-regulation prevails; vocation is a determinant in learning orientations; and in mental models, utilization of learning prevails. These findings also indicate that cardiology residents tend to have an application-directed learning style.

Past work is consistent with and informs the present study. In accordance with Ramsem and colleagues (1984), the nature of teaching style can influence a student's learning style (Newble & Hejka, 1990). This includes teaching methods as well as the level of commitment and enthusiasm imparted by the faculty. All residents participating in this study belong to a group selected from teaching programs at the University of Buenos Aires. These institutions were selected because they have the appropriate infrastructure and faculty to impart the standards of education needed to carry out this survey. This favourable "platform" serves to stimulate residents to develop an application-directed learning style (Alves de Lima, 2005).

Additionally, Newble and colleagues evaluated learning styles of a sample of 308 residents, observing a marked difference in the manner of approaching their studies, among both those with and without post-graduate training (Newble & Hejka, 1990; Newble & Gorgon, 1985; Ramsem, 1984). Those with post-graduate studies demonstrated a learning style deeply affected by acquired knowledge (Newble & Hejka, 1990).

Although no significant differences between learning styles for men and women were detected in the present study, Severiens and Dam (1997) found that more men than women had undirected learning styles, while women had more reproduction-directed learning styles. This is an issue that may warrant future investigation.

Students with an FA lower than the mean tended towards learning for the sake of certification. This characteristically is a reproduction-directed learning style. When considering that the FA is the average of all grades obtained throughout a student's study career, the findings concur with past work. Reproduction-directed learning styles demonstrate a negative correlation in relation to exam results (Vermunt, 2003).

There are important, mediating factors that call for a cautious interpretation of the present findings and these should be taken into account. Although the study questionnaire had been validated by the author in the English language, this is not the case for the translation used for this study. Boyle and Duffy tested the possibilities of generalization of Vermunt's integrated model of learning with a sample of students from a British University and established whether different learning styles were associated with different academic outcomes. Confirmatory factor analysis was used to test Vermunt's four factor model of learning styles and compared it with alternative models (Boyle & Duffy, 2003).

Cronbach's Alpha Coefficients are low in some learning style components (e.g. learning orientations, item: Certification: Cronbach Alpha coefficient 0.22). Cronbach's alpha provides reliability estimates and measures internal

consistency based on a single administration of the measure. It is an extension of Kuder-Richardson formula 20 (KR 20), allowing it to be used when there are more than two alternatives. Interpretability issues, probably related to the inventory translation may be the reason for this problem (Streiner & Norman, 1995).

The present work was carried out over a period of one complete year, wherein a resident is known to be developing throughout the course of his or her educational training. Those who answered the questionnaire at the start of the research study are not necessarily comparable to those who answered one year into the survey.

This research study has significant practical implications. Foremost it allows for the definition of the learning style adopted by a cardiology resident when approaching the activity of studying, which is inherently linked to the manner of teaching (Whitman, 1996). Information regarding learning styles can provide foundations upon which arguments can be made for changes in education that are traditionally not justified on the basis of evidence (Severiens & Dam, 1997; Marton, 1995; Marton, 1979).

Adequate design of training programs is vital, not only for the teaching processes, but also for constructing systems for evaluating progress (Alves de Lima *et al.*, 2005). It is necessary to be on constant alert regarding the effects of educational activities being implemented in order to redirect them in the event they are not rendering the desired educational impact.

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