

Critical thinking in virtual environments

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Abstract

In recent years Brazil has been occupying a position of economic prominence in the world, but it is not the same when it comes to quality of education, both at the basic and higher levels. The new generations born in the Digital Age, such as “Generation Y” or Generation “Z”, have several qualities, but among their deficiencies, they are worried about worshipping technologies that compete with other activities that develop critical thinking, such as reading and problem solving. The critical thinking skill (critical thinking) is emphasized as important for many types of practitioners and has been researched for many years. The general objective of this research was to empirically evaluate the application of Richard Paul’s Critical thinking development model in the Moodle virtual environment with students of accounting disciplines. A quasi-experiment was applied in the first semester of 2013 to undergraduate students in administration in the discipline of Business Budget and Comptrollership of a Higher Education Institution in the interior of the state of São Paulo. The critical thinking tool was the Ennis Weir Critical Thinking Essay Test (EWCTET). The main result was that the Richard Paul model did not have a significant effect on the development of critical thinking skills when applied in a mixed approach and through a Moodle virtual learning environment, contrary to previous research. For future research, larger samples are suggested to improve the statistical power of the results and the investigation of forms of control that intensify the students’ time dedicated to asynchronous activities.

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1. INTRODUCTION

Technological evolution in the area of teaching happens at an amazing speed. In the past, people used to search for knowledge in a printed bibliography, restricted to a few. Today a huge volume of information is present in the daily lives of the population. Whether through computers, tablets or smartphones, everyone has free access to the knowledge developed and spread by humanity.

The new generations born in the Digital Age, such as “Generation Y” or Generation “Z”, have several qualities, such as: the ability to multitask, to be selective of information and to seek activities that not only generate financial returns, but that are also rewarding. However, it is also observed that they present some deficiencies, for example: they cannot pay attention to an explanatory lecture for very long, they do not read texts in depth, and they love technologies to the detriment of activities that develop critical thinking, such as reading and problem solving.

In 1983, before the great technological and digital advance, the National Commission of Excellence in Education of the United States issued a report titled “A Nation at Risk”. This paper reported that most seventeen-year-olds lacked the intellectual skills that the country needed. After its publication, most US states developed programs that encouraged teachers to teach critical thinking, and one of the most famous programs, “Tactics to Think”, sold seventy thousand copies (WILLINGHAM, 2007).

Currently teachers compete with various technologies that distract their students and take away their attention, such as: electronic games, Internet, cell phones and social networks. There are several institutions and researchers that seek to develop new teaching methodologies and didactic strategies that can retain the attention of the student. However, when it comes to linking these strategies to models that improve critical thinking, it is noted that Brazil has a small number of studies with this focus.

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Among the several existing models for the development of skills and critical thinking are the Critical Thinking Assessment Test (CAT) developed by Ennis (1993); California Critical Thinking Skills Test (CCTST) by Facione (1990); Cornell Critical Thinking Test (CCTT) of Ennis et al. (1985); Critical Thinking Assessment Battery (CTAB) developed in 1997 and published by the American College Testing Program; Watson-Glaser Critical Thinking Appraisal (WGCTA), developed in 1994 and published by the American College Testing Program, among others. One can also cite the method designed by the American philosopher Richard Paul. It seeks, through the identification of the elements of reasoning, to organize a debate, an analysis of a text, or even the solution of a problem in a critical way (PAUL, 1995, PAUL, ELDER, 2000).

Based on the above and previous researches (Passos et al. (2013); Passos (2011); Quitadamo et al. (2008); Abrami et al. (2008); Cornacchione, Duncan and Johnson (2007); Braun (2004); Wilson (2002); Pithers and Soden (2000); Allen et al. (1999); Reed (1998); Bonk and Smith (1998); Baril et al. (1998); Stone and Shelley (1997); Kimmel (1995); Sormunen and Chalupa (1994); Riesenmy et al. (1991); Baldwin and Ingram (1991); and Bangert-Drowns and Bankert, (1990)), this paper has the following research question: Is there a relationship between Richard Paul's model in virtual learning environments and the development of critical thinking skills in students of accounting disciplines?

In order to attract students' attention with a technological tool, the general objective of the work was to empirically evaluate the effectiveness of teaching the Richard Paul model, via a virtual learning environment (Moodle), with higher education students, specifically students in an accounting class. The choice of a class in the accounting area was due to the researcher's training and the intention of comparison with the work of Passos (2011), who in his thesis obtained positive results in the development of critical thinking in students of the area. The aforementioned author justified the choice by explaining that the internationalization and harmonization of Brazilian Accounting Standards, after approval of Law 11.638/07 (New Corporation Law), increased the demand for accounting professionals with higher levels of critical thinking.

Therefore, the specific objectives of this work were:

- Analyze EWCTET distribution by the instruction method;
- Evaluate the critical thinking skills of both classes (experiment and control);

The work is justified by its contribution to continue research on the subject, mainly by testing the hypotheses of previous studies in Brazil, in order to verify if Brazilian students have the same characteristics as the students surveyed in other countries. The study also contributes to increase the amount of research of this nature in Brazil, in addition to relating the subject with other education technologies, especially virtual learning environments, since the literature is still lacking of analysis of these tests in the most modern educational technologies.

The article began with the introduction of the subject and some methodological definitions of the research developed. The second part deals with the bibliographic review, the third addresses its methodological procedures, the fourth presents the analysis of the data and the fifth is a discussion of the main conclusions, addressing its limitations and suggestions for future research.

2. REVISION OF THE LITERATURE

In the United States the literature that deals with the topic of Critical Thinking (translated as "*Raciocínio Crítico*" in the Portuguese version of this article) is vast, and the subject has been studied for decades. There is no consensus in Brazil about the translation of the term, and many words are found for its meaning, such as: *Pensamento Crítico* (Critical Thinking), *Pensando Criticamente* (Thinking Critically), *Argumentação Lógica* (Logical Argumentation) and *Raciocínio Lógico* (Logical Reasoning).

The definitions are very similar, but they are also not consensual, as can be seen in Table 1 below:

Table 1. Definitions of Critical thinking

Author	Definition
MCPECK (1981)	[...] the main meaning of critical thinking is the propensity and ability to engage in an activity with reflective skepticism.
LIPMAN (1988)	[...] thinking that facilitates judgment because it is based on criteria and on self-correction, and is context-sensitive.
SIEGEL (1988)	[...] focus on the reasons and on the power of the reasons for securing or justifying beliefs, allegations and actions. A critical thinker, then, is someone who is appropriately moved by reasons: he has the propensity or attitude to believe and act according to reasons; and has the appropriate ability to assess the strength of reasons in many contexts in which they play a role.
FACIONE <i>et al</i> (1990)	We understand critical thinking as objective and self-regulatory judgment that results in interpretation, analysis, evaluation and inference, and also as an explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations on which judgment is based.
ENNIS (1993)	[...] reflective rational thinking that is focused on deciding what to believe or do.
PAUL (1995)	If thinking is disciplined to serve the interests of an individual or group to the exclusion of other people or groups, we call it sophisticated critical thinking or weak sense. If thinking is disciplined to take into account the interests of various people or groups, we may call it fair critical thinking or strong sense.
PASSOS (2011)	Critical thinking is thinking that facilitates judgment, because it identifies, analyzes and judges the elements of reasoning. The elements of reasoning are: objective, problem, information, interpretations, concepts, assumptions, implications and point of view.

Source: Prepared by the authors

Analyzing the table, it is verified that there is consensus in relation to critical thinking being organized thought, involving judgment and analyzing the arguments and facts presented on a discussed object. The good critical thinker will be willing to change their opinion based on the analysis of new judgments, arguments or facts presented that better elucidate the object discussed, be it a conversation, a debate, the analysis of an article, a book or even a movie.

In 2008, a meta-analysis identified and summarized the empirical evidence available in 117 studies covering 20,698 participants on the impact of interventions on the development of students' critical thinking skills or attitudes. This study concluded that the type of intervention and teaching methodology is related to the levels of development of critical thinking. It is clear from this research that the improvement or development of students' critical thinking skills or attitudes cannot be a mere implicit expectation of pedagogical projects and educators (ABRAMI *et al.*, 2008).

In 2007, an article published in the accounting area in Brazil explored critical thinking, reading and writing in a sample of 65 Accounting Sciences undergraduate and postgraduate students of the Faculty of Economics, Administration and Accounting of the University of São Paulo (FEA-USP). Through statistical analysis, the study focused on the elements for improving students' performance in relation to their critical thinking skills. This work reflected on the role of educators as agents of change in the scenario of higher education. The results pointed to indications of good writing quality and evidence of high levels of critical thinking. No significant differences were observed in metrics on readability levels of the generated written products. The study also suggested that cultural differences in critical thinking, related to the perception of authority, should be examined in future research. (CORNACCHIONE; DUNCAN; JOHNSON, 2007).

In 1998, Jennifer H. Reed defended her thesis that investigated the application of Richard Paul's model for critical thinking development in a North American History course. The purpose of the intervention was to develop: skills to think critically about North American History and about daily subjects; attitudes to think critically; and knowledge about the syllabus of North American History. The study also examined whether age or gender influenced the efficiency of the instructional method (REED, 1998).

Passos (2011) and Passos et al. (2013) continued the work of Reed (1998) and applied Richard Paul's critical thinking development model to students of accounting disciplines. First, a pilot quasi-experiment was conducted at a public institution during the second half of 2010. It was applied in a general approach (four 30-minute interventions) and the researcher was a class monitor. In the first semester of 2011, the second quasi-experiment was conducted in a private institution, and had a mixed approach (classes and activities of the experiment class) application and the researcher was the teacher of the classes. In the two experiments, participants filled out three assessment questionnaires: two of them were applied at the beginning and the end of the semester, and evaluated skills (Ennis Weir Critical Thinking Essay Test – EWCTET) and attitudes (California Critical Thinking Dispositions Inventory – CCTDI) of critical thinking; and one was a demographic survey (applied at the end of the semester).

Descriptive analyses of the samples were performed and covariance analysis (ANCOVA) was used to test the hypotheses using the pre-tests as covariates. In the public institution there was no significant effect of the model on the development of critical thinking skills or attitudes and no difference considering the isolated effect of the variables age or gender. In the private institution, two hypotheses were confirmed: the experimental class ($p = 0.040$ and $d = 0.56$) and older students ($p = 0.047$ and $d = 0.58$) presented greater development of critical thinking skills. Although the means of attitudes were not significantly different, there was also a significant effect of the instructional model on the development of the attitude of curiosity ($p = 0.047$ and $d = 0.65$). Significant differences in abilities were also observed for the isolated effects of age ($p = 0.002$ and $d = 0.77$) and gender ($p = 0.016$ and $d = 0.60$); and for attitudes in the isolated effect of gender ($p = 0.033$ and $d = 0.46$).

Richard Paul's model considers elements of reasoning and universal intellectual standards that are used to develop people's reasoning and attitudes. Paul presents his approach to developing critical thinking as a general model that can be applied to any problem or subject requiring reasoning. His theory is that to develop critical thinking in students it is necessary to teach them to think critically (REED 1998). The results of applying this model through a virtual learning environment are expected to bring contributions to research on business education and help teachers to think about using new methodologies that can develop skills and attitudes required by the job market.

3. METHODOLOGICAL ASPECTS

The work applied a research protocol similar to those of Reed (1998), Passos (2011) and Passos et al. (2013) with pre-tests and post-tests evaluating critical thinking skills. First, the descriptive analyses and correlations of the students' demographic and academic data were performed. The aim was to verify possible variables that could explain the differences of the performances between the classes. As it was not possible to randomize each student into the experiment group, rather the class as a whole, the research was classified as a quasi-experiment (BICKMAN; ROG, 1998).

The Mixed approach of application of Richard Paul's critical thinking development model was chosen. Ennis (1993) classifies approaches to teach critical thinking as follows:

- General: Regardless of content, critical thinking skills are taught to students.
- Infusion: requires deep reflection on a subject and, additionally, general principles of reasoning are taught and applied in the activities developed.
- Immersion: students are encouraged to think critically about a particular subject; however, the general principles of critical thinking are not presented.
- Mixed: A mixture of the General with Infusion or Immersion; students are engaged in a course in which they critically analyze a subject with or without explicit general concepts of critical thinking; however, there is a separate part of the course that aims to teach general principles of critical thinking.

Richard Paul's model for critical thinking development was taught via Moodle and applied to the experiment class, the other class of the same semester and discipline received a traditional method of teaching. The asynchronous interventions in the experiment class were weekly, and in ninety percent of the cases via a virtual learning environment, and most of the time a closing brief of the activity was carried out in person and an incentive for the final average was always used. Journalistic texts, scientific articles, book chapters and problem situations were used for debates using Richard Paul's critical thinking model. For each activity there was a guiding text that explained how to use Paul's model, and the doubts could be exposed in specific forums. Asynchronous activities were chosen because they were extra-class activities, making it impossible to participate in a scheduled activity. Pre-tests were applied at the beginning of the third week of school, and post-tests at the end of the semester to assess students' critical thinking skills (EWCTET).

The Ennis-Weir Critical Thinking Essay Test (EWCTET) was applied to assess the students' ability to analyze an argument and respond critically in writing to a subject in question. This instrument assesses the ability to respond to arguments when they appear naturally in a real-world discussion, dispute or debate (ENNIS; WEIR, 1985; CORNACCHIONE, DUNCAN; JOHNSON, 2007; REED, 1998; PASSOS, 2011; PASSOS et al., 2013). The test has a page written by a newspaper editor who seeks to convince the public about the adoption of a law prohibiting parking on public streets at night.

The letter has eight numbered paragraphs and another with a summary. Participants need to review each paragraph of the test letter in order to write a short essay agreeing or disagreeing with each argument. Those responsible for developing the test created a form with the criteria for evaluating each of the nine paragraphs written in response to the letter. Students can score from -9 to 29. In the analysis of the first eight paragraphs, scores can vary from -1 (analyzed incorrectly) to 3 (analyzed and justified correctly). In the last paragraph, the correction criteria allow it to be evaluated from -1 to 5. The maximum recommended duration is 40 minutes. For more information on the method see Ennis and Weir (1985).

Prof. Robert H. Ennis is an expert on the subject and has several articles published in the area. Reed (1998) comments that EWCTET has been used in many surveys and has received strong support from experts. Cornacchione, Duncan and Johnson (2007), Passos (2011), Passos et al. (2013) and the present research obtained permission from Professors Ennis and Weir to use the test. The reliability of the test is analyzed using two different evaluators for 27 essays written by students of an informal logic course and 28 essays by eighth grade students of an English course. Correlations of 0.86 and 0.82, respectively, were obtained, which are high for a writing test. The test literature addresses four types of validity: content, prediction, agreement, and construction. The most appropriate validity for EWCTET is that of content (ENNIS; WEIR, 1985).

The tests are applied to both classes, and each class with the specific teacher. The EWCTET scores were the means of two evaluators. In the evaluation process, any difference greater than three points causes the essay to be reviewed and discussed by the evaluators until reaching the maximum difference of three points. The revisions of both classes (control and experiment) are performed in a single session (REED, 1998; PASSOS, 2011; PASSOS et al., 2013). Immediately after the first correction (before the revisions) of the evaluators the reliability of the test is calculated and analyzed by means of the correlation coefficient (Pearson's r).

Statistical analysis seeks to test significant differences between the two classes. Since the classes present scores with a significant difference to a normal distribution, we chose to use three non-parametric tests: the Mann-Whitney test; the Wilcoxon signed rank test and the Wilcoxon rank sum test (FIELD, 2009). In order to validate the research model in relation to the possible bias in the quality of the teaching methodology by the instructors, access to the evaluations of the classes by the institution's faculty was requested and no significant differences between the evaluations of the two teachers were noted. All participants knew they were taking part in a survey and to avoid the Hawthorne effect, they did not know whether they belonged to the control or experiment group.

Therefore, in short, the empirical research methodology follows the following steps:

1. Application of the Richard Paul model via the Moodle environment in a class of the undergraduate course in Administration in the discipline of Business Budgeting and Comptrollership of a Higher Education Institution (HEI) in the interior of the state of São Paulo;
2. Application of a traditional method of teaching in a class of the same semester and discipline cited above, in the same institution;
3. Application of a pre-test and an EWCTET post-test that evaluates critical thinking skills of both classes (experiment and control); and

4. Comparison of the results with previous research, especially the researches of Reed (1998), Passos (2011) and Passos et al. (2013).

SPSS for Windows version 13.0 and Excel 2010 software were used for the execution of the statistical treatments and analysis of the data.

4. RESULTS AND DISCUSSION

Firstly, some demographic data were analyzed to support the possible explanations of results and comparisons with previous research.

From the total of 18 students on the morning Administration course, 13 students opted to participate in the survey and completed the pre-tests at the beginning of the semester and the post-tests at the end. They had an average age of 21.8 years; the majority (69 %) were male; the most frequent high school graduation year was 2009; only one student was married; only one student had a child; the average family income was 5.7 minimum wages; the majority (54 %) said they “rarely” read any book or article, while the others (46 %) said they read “often”; and the majority (77 %) did not speak a foreign language fluently, while a minority (23 %) said they spoke English.

In the control class of the evening Administration course, of a total of 43 students 15 students chose to participate in the survey and completed both tests. The mean age was 22.0 years; the majority (67 %) were female; the mode for the year of graduation was 2010; all students were single; none had children; the average family income was 7.0 minimum wages; there were more (53 %) “frequently” responses to reading habits, followed by “rarely” (40 %), and lastly “almost never” (7 %); and the majority (67 %) said they did not speak any foreign language, while some (33 %) claimed to speak English fluently. Although the classes are different shifts (morning and evening) of the Administration course, the profile of the students does not change significantly, as determined by the socioeconomic questionnaire available at the HEI.

Analyzing the data of the two classes it is verified that, except for the percentage of each class that chose to participate in the study fulfilling all its requirements and for gender distribution, the other variables: age group, year of high school graduation, marital status, family income, reading habits and foreign language were very similar, which makes the quasi-experiment possible. The two exceptions are considered in the analysis of the results and make up the list of possible limitations of the present study.

Table 2 below presents descriptive statistics of the EWCTET of the experiment and control classes in their pre-tests and post-tests.

Table 2. Distribution of EWCTET by instruction method

Measures	Experiment Class (n = 13)		Control Class (n = 15)	
	Pre-test	Post-test	Pre-test	Post-test
Mean	4.92	6.38	3.13	4.60
Median	5.00	4.00	2.00	5.00
SD	10.04	8.37	9.06	2.08

Source: SPSS version 13.0

It is noteworthy that both classes had higher mean scores in the post-tests, but it is necessary to test if there is a significant difference between the post-tests and pre-tests within and between each class to infer about possible relationships between the method of instruction in the Moodle virtual environment and the development of critical thinking skills.

Histograms were analyzed and one of the distributions appeared to be non-normal. The Kolmogorov-Smirnov (K-S) test confirmed that the control class pre-test scores were significant ($p < 0.05$), indicating that the sample was not normal. We tried to transform the data, but none of the options (square, log, square root, cube etc.) were able to correct the problem and normalize the distribution. Therefore, when it is not possible to meet the requirements of a parametric statistical tool, the non-parametric tests are an option (FIELD, 2009).

To test differences between two conditions and different participants of a non-normal distribution one can use the Mann-Whitney non-parametric test and the Wilcoxon rank sum test. It can be said that these tests are the nonparametric versions equivalent to the parametric t test (Student) (FIELD, 2009).

Table 3. Mean Position and Mann-Whitney Rank Sum

	Class	N	Mean Rank	Rank Sum
EWCTETpre	Experiment	13	14.88	193.50
	Control	15	14.17	212.50
	Total	28		
EWCTETpost	Experiment	13	14.77	192.00
	Control	15	14.27	214.00
	Total	28		

Source: SPSS version 13.0

Analyzing Table 3, it is verified that in the pre-tests and in the post-tests the class with the lowest average in their ranks is the control. Therefore, it can be said that it has the highest number of low ranks. This first result presents positive indications of the quasi-experiment, since the experiment class obtained higher scores in the test that measures critical thinking skills. However, one should analyze with caution, since it cannot be said that there was an improvement between the pre-tests and the post-tests within each class or that the pre-tests and post-tests of the classes are different.

Table 4. Mann-Whitney and Wilcoxon test

	EWCTETpre	EWCTETpost
Mann-Whitney U	92.500	94.000
Wilcoxon W	212.500	214.000
Z	-0.231	-0.162
Asymp. Sig. (bilateral)	0.817	0.872
Exact Sig.	0.821	0.892
Exact Sig.(bilateral)	0.829	0.883
Exact Sig. (unilateral)	0.414	0.441
Point Probability	0.009	0.009

Source: SPSS version 13.0

It was verified that the pre-tests of the control class (median = 2.00) did not seem to differ from the experiment class (median = 5.00), $U = 92.50$ was not significant, $z = 0.04$. The same happens with regard to post-tests, the control class (median = 5.00) was not significantly different from the experiment class (median = 4.00), $U = 94.00$, ns, $z = 0.03$. By calculating effect sizes, it is observed that (0.04 and 0.03) are small, indicating that it would be necessary to increase the number of participants to achieve greater statistical powers.

The result of the above test indicates that there are no statistically significant differences between the pre-tests and between the post-tests of the control and experiment classes, giving evidence that the Richard Paul model applied through Moodle during the semester did not develop critical thinking skills in the students of the experiment class.

The Wilcoxon test is a non-parametric test similar to the dependent t-test that can be used in situations where there are two sets of scores of the same participants (FIELD, 2009). Therefore, it will be used in this study to test if there was a change in the reasoning throughout the semester in each class.

Table 5. Wilcoxon Rank Signs for the Control Class

		N	Mean Ranks	Rank Sum
EWCTETpos - EWCTETpre	Negative Ranks	5 ^a	6.30	31.50
	Positive Ranks	8 ^b	7.44	59.50
	Equals	2 ^c		
	Total	15		

Source: SPSS version 13.0

Note: ^a EWCTETpost < EWCTETpre; ^b EWCTETpost > EWCTETpre; ^c EWCTETpost = EWCTETpre

According to Table 5, it is verified that the majority (8) of the students in the control class obtained better performance in the post-tests in relation to the pre-tests. At first this result seems to indicate that there was improvement in the critical thinking abilities of the control class.

Table 6. Wilcoxon Signed Rank Test for the Control Class

	EWCTETpost - EWCTETpre
Z	-0.980 ^a
Asymp. Sig. (bilateral)	0.327
Exact Sig. (bilateral)	0.347
Exact Sig. (unilateral)	0.174
Point Probability	0.009

Source: SPSS version 13.0

Note: ^a Based on the Negative Ranks.

Analyzing Tables 5 and 6, it can be said that the post-tests (median = 5.00) were not significantly higher than the pre-tests (median = 2.00) of the control class, $T = 6.30$, ns, $S = 0.19$, therefore, it cannot be affirmed that there was an increase in the critical thinking abilities in this class during the semester. The effect size (0.19) is small to medium, so it is suggested that future studies try to increase the number of participants to obtain greater statistical powers.

Table 7. Wilcoxon Rank Signs for the Experiment Class

		N	Mean Ranks	Rank Sum
EWCTETpost - EWCTETpre	Negative Ranks	4 ^a	6.88	27.50
	Positive Ranks	8 ^b	6.31	50.50
	Equals	1 ^c		
	Total	13		

Source: SPSS version 13.0

Note: ^a EWCTETpost < EWCTETpre; ^b EWCTETpost > EWCTETpre; ^c EWCTETpost = EWCTETpre

Analyzing Table 7 above, it can be observed that the majority (8) of the students performed better in the post-tests in relation to the pre-tests. However, it cannot be said that this is due exclusively to Richard Paul's model of critical thinking development, since this statistical test does not measure this interaction. If the samples had shown to be normal, ANCOVA would have been able to test this interaction, since it works with a multiple regression model in which one of the independent variables is the class. That means that the extent to which the intervention explains the model of a class in relation to the other could be tested.

Table 8. Wilcoxon Signed Rank Test for the Experiment Class

	EWCTETpost - EWCTETpre
Z	-0.904 ^a
Asymp. Sig. (bilateral)	0.366
Exact. Sig. (bilateral)	0.395
Exact. Sig. (unilateral)	0.197
Point Probability	0.015

Source: SPSS version 13.0

Note: ^a Based on the Negative Ranks.

According to Tables 7 and 8, it was found that for the students in the experiment class the post-test (median = 4.00) was not significantly higher than the pre-test (median = 5.00), $T = 6.88$, $S = 0.18$. It is observed that the effect size (0.18) is small to medium, indicating that a larger number of participants would improve statistical power. Therefore, it can be said that there was no significant difference between the post-tests and the pre-tests of the experiment class, although most of the students improved their position in the post-tests.

The analyses indicate that there was no critical thinking development using the Richard Paul model in a mixed approach in the Moodle virtual environment. However, the research fosters an increase in the discussion about different methodologies and resources that can at the same time improve student learning and develop skills required by the professional and academic market.

Comparing these results with previous research, we find that this study contradicted Reed's (1998), who found in his thesis that History undergraduate students who were exposed to Richard Paul's critical thinking model obtained a better result in the EWCTET (REED, 1998). The author also used a mixed approach, in which interventions were frequent, but all interventions were face-to-face and there was no support for a virtual learning environment.

In relation to the researches of Passos (2011) and Passos et al. who performed two quasi-experiments, one in a general approach and another in a mixed approach, this study corroborates the results of the first, differing in relation to the approach (general versus mixed), and opposes the second, which has the same approach (mixed). However, comparing that of the similar approach, one of the possible explanations may be the intensity of the interventions in the face-to-face model, since one of the limitations in the virtual model was the lack of monitoring of the time spent by the students in the solution and analysis of the asynchronous activities.

When comparing the means obtained in the post-tests of the experimental (6.38) and control (4.60) classes with data from previous research in the EWCTET Handbook Supplement (University A = 13.1 and University B = 14.3) (ENNIS, 1998), with the result of the research of Cornacchione, Duncan and Johnson (2007) (USP Group = 15.1) and with the works of Passos (2011) and Passos et al. (2013) (FEA-USP = 12.50; Private Institution = 4.91), it can be said that the performance of the students of this research was well below those of the international institutions and of the Brazilian public institutions cited, but very similar to that of the private institution of the study by Passos (2011), suggesting the need for future research that analyzes critical thinking by type of institution (e.g. private versus public).

In addition to the study by Reed (1998) and Passos (2011), the result of this research contradicts the theories or conclusions of the following researches: Abrami et al. (2008); Quitadamo et al. (2008); Cornacchione, Duncan and Johnson (2007); Braun (2004); Wilson (2002); Pithers and Soden (2000); Allen et al. (1999); Bonk and Smith (1998); Baril et al. (1998); Stone and Shelley (1997); Kimmel (1995); Sormunen and Chalupa (1994); Riesenmy et al. (1991); Baldwin and Ingram (1991); and Bangert-Drowns and Bankert, (1990). However, it corroborated the results of the following studies: McMillan (1987); Adams (1999); and Passos et al. (2013). Most of the studies cited were carried out with undergraduate students, used varied approaches and models, and did not use virtual environments, but had a similarity in their intention to develop critical thinking skills.

5. CONCLUSIONS

The main result of this research answered its problem: the students in the experiment class did not perform better than the students in the control class in a test that evaluates critical thinking skills. Therefore, it can be said that the Richard Paul model did not have a significant effect on the development of critical thinking skills when applied in a mixed approach and via the Moodle virtual learning environment.

Reflecting on Lipman's ideas (2003), thinking means possessing a concept, opinion or belief, and this does not imply the use of good judgment. Any thinking that involves criteria, comparison, and is based on standards is considered reasoning. The critical thinking model applied in the experiment class via Moodle was intended to encourage students to use criteria and standards to think about a particular object of study (article, book, problem, etc.).

The application of Richard Paul's critical thinking skills development model in a mixed approach, explaining how to use the model and applying it in several activities during a semester, has already obtained a positive result in previous research (PASSOS, 2011; REED, 1998; ABRAMI et al., 2008), but no previous research conducted via a virtual learning environment was found. One of the possible explanations for the negative result may be attributed to a low intensity of the applications, a fact that was not observed in the asynchronous activities through the virtual learning environment. Further research should be undertaken into possible ways to control students' work in virtual environments.

Analyzing the data of the two classes in search of previous differences in critical thinking skills, it is verified that the percentage of each class that chose to participate in the research and the variable gender compose the list of possible limitations of the present study. This research is justified by continuing the theme, the previous researches and the insertion of the variable virtual learning environment as an attraction to the students of the new generations. This research contributes to increase the discussion about different methodologies, tools and resources that can at the same time improve student learning and develop skills required by the professional and academic market.

For future research, larger samples are suggested, making it possible to improve the statistical power of the results and the investigation of forms of control that intensify the students' time of dedication in synchronous or asynchronous activities. Because the results of the tests of students from private institutions have been well below public international and Brazilian universities, it is suggested that future investigations consider the variable type of institution (public vs. private). It is also suggested that future research apply the model in undergraduate or postgraduate courses in different approaches (General, Infusion, Immersion or Mixed) and with different virtual learning environments, tools and technological resources, such as: business games, tablets, cell phones, discussion boards, quizzes, etc. (ENNIS, 1993).

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