Developing critical thinking across the curriculum through embedded personal epistemology: An immersion approach

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Abstract

In the present-day information age, it has become more crucial than ever to be equipped with an intellectual compass that can help an individual to navigate the overwhelming deluge of information, messages, and discourses. The efficiency of higher education in teaching students to think critically is debatable as most institutions treat these skills in isolation from the rest of educational goals. This paper explored a holistic approach to enhancing critical thinking across the curriculum. It involves the promotion of learners' epistemological beliefs. The study explored a potential causal relationship between critical thinking skills and epistemological beliefs among undergraduates at the Department of English at Khenchela University, Algeria. In a quasi-experimental design, sophomores received a two-semester treatment instruction designed to promote their critical thinking skills. These latter were tested in pre-and post-tests to evaluate the effect of the course. T-test results revealed a significant change in the experimental group's post-test means as compared to their critical thinking pre-tests.

Keywords: Critical thinking; epistemic climate; higher education; immersion; personal epistemology.

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1. Introduction

Modern societies have never been in utter need of critical thinkers, yet, paradoxically, they have never been less incapable of meeting those needs (Davies & Barnett, 2015; Freire & Feinauer, 2022; Murphy, Ogata & Schoute, 2023). Even though it is even considered a national priority by some governmental institutions (Harrell & Wetzel, 2005), developing students' Critical Thinking (CT) skills still appears to represent a major challenge. Therefore, extensive research has been published on ways to improve it in different educational contexts. Fortunately, fostering CT is possible through classroom instruction (Halpern, 1993; Tsui, 2002; Tiruneh et al., 2014; Pnevmatikos, Christodoulou & Georgiadou, 2019; Liu & Nesbit, 2023). The literature addressed numerous potentially effective teaching approaches, techniques, and methodologies. For instance, constructivist approaches, cooperative learning methods (Lai, 2011), and instructional strategies such as constructing argument diagrams (Harrell & Wetzel, 2005) did show certain effectiveness in developing students' CT skills. However, the success of research to establish the best instructional approaches and teaching strategies toward that goal remains quite limited (Halpern, 1993; Terenzini et al., 1995; Tiruneh et al., 2014; Jung & Lee, 2022). There is also a wide disagreement over the best approach to teaching CT: whether separately or across the curriculum. Research seems to favor stand-alone CT courses, but access to or even availability of such courses is widely limited, for various reasons (Davies & Barnett, 2005; Mohammadi, Abbasian & Siyyari, 2022). Local and contextual constraints as well as a lack of scholarly agreement hinder the quest for a leading, harmonious instructional methodology that would help meet this global need.

The present study explores an alternative approach to CT instruction. It is based on the idea that CT is grounded in one's attitude toward the knowledge that one is asked to be critical about. When this attitude is mature enough, the individual would spontaneously feel the need to be critical (Kuhn, 1999). The argument of this paper relocates the source of CT learning to the learners themselves. Indeed, there has been considerable scholarly attention, since the late 1960s, to the study of one's attitudes toward knowledge. This field came to be known as *personal epistemology* (PE) or *epistemological beliefs* (EBs). According to this literature, an individual's beliefs about knowledge shape their thinking, learning, and performance (Hofer & Pintrich, 1997; Hofer, 2002).

Indeed, some scholars state that for a student to think critically, they need to hold a sophisticated level of epistemological understanding (Kuhn, 1999). Thus, epistemological awareness represents the root from which CT is to be developed. This study aimed to empirically investigate the relationship between CT and EBs in a higher education setting. The purpose was to explore whether there is a causal relationship between the two variables. This relationship could serve a holistic, across-the-curriculum promotion of CT, all domains and levels included. This study is meant to answer the gap in the local as well as the foreign language teaching literature about these two constructs.

1.1 Literature review

1.1.1 Personal Epistemology

Epistemology is "the philosophical study of knowledge: its nature, its requirements, and its limitations" (BonJour, 2010, p. 1). Epistemological beliefs or personal epistemology, refer to a human being's perception of these aspects of knowledge (Han, Kang & Sok, 2022). They concern "how individuals come to know, the theories and beliefs they hold about knowing, and how such epistemological premises are a part of and an influence on the cognitive processes of thinking and reasoning" (Hofer and Pintrich, 1997, p.88).

Personal epistemology has been conceptualized along several theoretical frameworks. In Perry's seminal work (1970), he theorized the construct and posited the first developmental scheme of EBs. Subsequently, several models drew on Perry's, four of which stand out in the literature. First, *the*

developmental models of epistemological thinking delineate a general progression in individuals' understanding and views of knowledge (Perry, 1970; Baxter Magolda, 1992; King and Kitchener, 1994; Soleimani, 2020). Although they differ in some respects, their progression schemes seem to meet roughly in the main line. Mainly, it evolves from *absolutist knowing* (Baxter Magolda, 1992) which believes that knowledge is certain, held, and handed down by authority (parents, experts). Then as absolutists recognize the uncertainty of knowledge, they become *multiples* (Kuhn, 1999) and consider all knowledge claims as equally valid opinions. Finally, these individuals reach an *evaluative* epistemological understanding where they realize that some claims are more valid and justified than others (Kuhn, 1999).

The second PE framework is *the beliefs model* consisting of a set of more or less independent, yet related beliefs about knowledge and knowing (Shommer, 1990; Kardash and Scholes, 1996; Qian and Alverman, 2000). Third, is *the epistemological theories' model* (Hofer & Pintrich, 1997) that conceptualizes the construct as four identifiable and interrelated dimensions that develop in predictable tracks. Fourth is *integrative models* (Bendixen & Rule, 2004; Greene et al., 2008).

Bendixen and Rule's (2004) Integrative Model (*IM*) is of particular interest to this paper. It is developed around the mechanisms of *epistemic change* (i.e., EBs changing from naïve to more sophisticated reflection) and how to foster its development. It posits that change goes through three phases: *epistemic doubt*, *epistemic volition,* and *resolution strategies*. Epistemic doubt consists of "a specific form of cognitive dissonance associated with questioning one's beliefs about knowledge and knowing" (Rule & Bendixen, 2010, p. 99). Epistemic doubt, then, needs the motivation to restore balance after the epistemic disequilibrium caused by the initial cognitive dissonance, namely *epistemic volition*. The third element in the *IM* is *resolution strategies*, which are the actions that the individual takes, motivated by volition, to modulate prior beliefs that were unsettled by doubt (Rule & Bendixen, 2010). The present research drew on this model in designing the instructional treatment.

A considerable amount of research has, indeed, studied the role of EBs in the process of learning, thinking and "how these beliefs affect or mediate the knowledge-acquisition and knowledge-construction process" (Hofer, 2001, p. 354). Findings have shown extensive evidence demonstrating the significance of this role (Schommer et al., 1992; Bendixen et al.,1998; Kardash & Howell, 2000; Qian & Alvermann, 2000; Hyytinen et al., 2014).

1.1.2 Critical Thinking

Defining CT has been a great challenge (Huber & Kuncel, 2016). Three lines of thought conceptualize CT differently: the philosophical (Ennis, 1985; Lipman, 1988; Facione, 1990; Paul, 1990; Bailin, 2002), the psychological/cognitive (Sternberg, 1986; Lewis & Smith, 1993), and the educational (Bloom et al., 1956). Although this contributes to the richness of the construct, it does add to the confusion (Wertz, 2019) faced by practitioners and theoreticians. Despite the apparent difference, the contributions of all these schools of thought seem to work together. Wertz (2019) states:

> In looking at what CT is thought to be, the philosophical ideas of reasoning and judgment are more fully described by understanding the underlying psychological processes. These processes then, in turn, make up the reflective judgment cited by education as what CT is. The how of CT is the widest point between disciplines but most components are redundant between disciplines. (p. 15)

Davies and Barnett (2015) also suggest that those differences do not change the core of CT. This paper joins this argument and, as Kuhn (1999) puts it, "critical thinking by definition involves reflecting on what is known and how that knowledge is justified" (p. 23). Thus, in this paper, it was deemed fair to align with the almost agreed-upon description of the construct, which includes the cognitive skills of argument analysis, inference using inductive or deductive reasoning, evaluation, decision-making, and problem-

solving. It also involves a set of dispositions (attitudes or habits of mind), such as open-mindedness, "inquisitiveness, flexibility, a propensity to seek reason, a desire to be well-informed, and a respect for and willingness to entertain diverse viewpoints" (Lai, 2011, p. 2).

1.1.3 Critical thinking and epistemological beliefs

Bailin (1999) argues that a useful way to think about the trouble that students have with university tasks that entail CT skills "is in terms of epistemological understanding" (p. 162) and that conceiving of these skills as pure abilities and dispositions has not helped in understanding that problem. She holds that although students could become able to evaluate arguments and engage in other CT skills, they would lack a higher-level consciousness of the nature of this endeavor. According to Kuhn's (1999) developmental model of CT:

> The development of epistemological understanding may be the most fundamental underpinning of critical thinking. If knowledge is entirely objective, certain, and simply accumulates, unconnected to the human minds that do the knowing – as the absolutist conceives – or if knowledge is entirely subjective, subject only to the tastes and wishes of the knower – as the multiple conceives – critical thinking and judgment are superfluous (Kuhn, 1999, p. 23).

King & Kitchener (1994; 2004) suggest that EBs and CT are related but distinct. What distinguishes CT and PE is a "distinction between thinking about how knowledge is generated and justified in comparison to more specific inductive reasoning and thinking" (Hofer & Pintrich, 1997, p. 117). In their reflective judgment model of PE, King & Kitchener conceptualized a developing pattern of EBs and noted that people's ways of dealing with ill-structured problems evolve as they develop epistemologically. This suggests that EBs compose the intellectual environment within which CT skills can develop. Epistemic assumptions, thus, account for the way individuals use logic, justification, and other cognitive skills to solve complex issues, especially ill-structured problems (Kitchener, 1983).

Empirically, previous research has established a close positive relationship between the sophistication of EBs and CT (Brabeck, 1983; Peterson, 1995; Hyytinen et al., 2014; Ferguson & Bubikova-Moan, 2019; Mitchell et al., 2020). Furthermore, epistemological understanding is of considerable importance to the development of CT skills and dispositions (Kurfiss, 1988; Mines et al., 1990; Peterson, 1995; Gallagher, 1998; Jones et al., 1999; Chan et al., 2011; Barzilai & Zohar, 2012). Additionally, PE has been observed to be advantageous to many reasoning skills constituting important aspects of CT, like dealing with conflicting views and controversial issues (Schommer, 1990; Kardash & Scholes, 1996; Schommer-Aikins & Hutter, 2002), argumentation (Bråten et al., 2014; Ferguson & Bubikova-Moan, 2019), and problem-solving strategies (Bromme et al., 2010). In sum, EBs were perceived to act like an intellectual mindset, an epistemic disposition to perform CT cognitive skills in a certain way, depending on the sophistication of EBs. This suggests considerable potential for educational CT endeavors. The present paper, thus, attempted to tap into this potential in its intervention.

1.2 Purpose of study

This study examined the impact of a two-semester traditional university Study Skills course, redesigned to integrate sophisticated epistemological concepts (about the nature, sources, certainty, construction, etc. of knowledge) on participants' CT skills. Due to the lack of random sampling, a quasi-experimental design (Gall & Borg, 1989) was implemented to answer the research question:
RQ2 - What is the impact of the epistemologically informed course on the CT performance of students?

2. Materials and Methods

2.1 Participants

Participants of this study were second-year students (N=66) at the Department of English at Khenchela University, Algeria. The convenience sample comprised 42 females and 14 males, with ages ranging from 18 to 23, distributed rather evenly among the experimental group (N=40) and the control group (N=29). Gender imbalance in the sample reflects the overall population demographics.

Participation consent was obtained verbally because the study was made purposefully inobtrusive with no interference with students' normal course of studies since it was an immersion course. Moreover, the details of the study were not revealed to students to avoid influencing the outcomes of the study through social desirability bias and priming effect.

2.2 Data collection Instruments

2.2.1 The Cornell Critical Thinking Test, Level X (CCTTX)

The Cornell Critical Thinking Test, Level X (CCTTX) was used to measure students' CT skills. It was developed by Ennis, Millman, and Tomko (2005). It is a 17-page, 71-item multiple-choice test, measuring the CT ability of young students. It tests induction, deduction, observation, credibility, assumptions, meaning, and dispositions. The last two are not directly tested (Ennis et al., 2005). The test has two levels: X for 14 graders and Z for university students. Yet, the authors stated that the choice should take into account "the level of sophistication of the students" and "the amount of CT instruction they have had" (Ennis et al., 2005, p. 3). Because of the language barrier and the lack of prior encounters with CT instruction, Level X was chosen for this study. The choice of this measure was justified by its inexpensiveness, simplicity of administration, and the frequency of its use in higher education studies (Wertz, 2019; Mines et al., 1990).

To test the Cornell CT test's reliability, Ennis et al. performed two statistical tests: the Spearman-Brown method and the Kuder-Richardson approach, which estimate internal consistency. Consistency estimates for Level X range from .67 to .90, which are significantly positive. In addition, an external study conducted by Landis and Michael (1981) reported a Cronbach's Alpha of 0.77 as an internal consistency estimate for the CCTT Level X. Furthermore, to test the construct validity of Level X and Z, Ennis et al., (2005) collected at least 11 types of evidence, some of which are (1) reasonable judgments about the acceptability of the answers, and (2) simple internal statistics analyses, such as item analyses and internal consistency indices. The findings showed, collectively, strong support for the validity of Level X as a test of CT ability. It is important to note that there does not seem to be a maturation concern about this measure's pre-test. The authors state that the reason this same test can be used as both pre-test and post-test is that conceiving "truly parallel forms is very difficult and usually results in two different tests", making comparability problematic (Ennis, et al., 2005, p. 42).

2.2.2 The instructional treatment

It involved immersion in a second-year English BA course (Study Skills) redesigned with embedded sophisticated epistemological concepts into its instructional practices. The objective was to foster undergraduates' epistemic understanding while preserving the original course objectives and adding a supplementary focus on underlying epistemic aspects. Within a constructivist framework, students were immersed in a set of activities whose goal was to engage students in the three-phase epistemic change process posited by Bendixen and Rule (2004).

Specifically, instructional activities included cycles starting with experiences that would trigger cognitive dissonance, monitor a volition atmosphere through, for example, reflective writing activities,

then lead them to resolve them through class discussion, writing assignments in groups, or individually. Epistemic doubt was triggered by diverging information activities, volition was maintained through actively keeping students in the first phase for a fairly long time, and resolution strategies included explicit reflection, class debates, group problem solving, and reflective writing assignments, to mention but these.

2.3 Procedure and Ethics

All necessary ethical permissions were sought before the beginning of the study. School authorities were informed and students participated voluntarily. The CCTTX was administered to the participants before and after the treatment (i.e., October - May). The control group received an informatory, direct transmission of study skill strategies. The teacher introduced the technique and explained its usefulness, its types (if any), and its steps. Then students performed tasks to apply the technique to a text or any relevant material chosen by the instructor. For example, the source evaluation lesson involved an explicit explanation of the different types of sources, the scholarly and popular distinctions, and how to recognize each. The application included having students choose several sources of each category from the Net, and present it to the teacher for revision.

The experimental group, on the other hand, received the two-semester treatment course. The whole course started with the reversed arrow experiment, which involved the class looking at an arrow put behind a glass of water, recording its direction on a piece of paper, then eventually discovering that it pointed in the opposite direction once the water glass was removed. The objective was to shake their certainty in immediate knowledge sources (the five senses) and hence introduce epistemic doubt into their cognition, right at the beginning of the course.

To follow up with the source evaluation lesson example, undergraduates were given the task of finding sources that prove climate change and others that deny it. To fulfill this first step, students had to critically read through the different sources to identify documents representing both positions of the controversy. Then, they had to evaluate and compare the chosen sources and decide about their reliability through the investigation of the source's biases and other kinds of criteria. This second step was done while bearing in mind their doubt, which functions as a motivation for them to resolve the dissonance, a dissonance that increased when they found reliable documents on both conflicting sides. Resolution strategies included group debates about the respective climate change sources, and writing assignments to expose and justify their process.

To achieve the study's objectives, two hypotheses had to be tested:

H1- The experimental group's post-test mean in CT will be significantly higher than its pre-test means.

H2- The experimental group's post-test mean in CT will be significantly higher than that of the control group.

2.4 Data analysis

The CCTTX scoring uses the formula "rights minus one-half the number wrong" to correct for wrong answers against making wild guesses (Ennis et al., 2005, p. 7). To examine the effect of the course (if any) on participants' CT skills, the pre-and post-test scores were analyzed. It should be noted that the CCTTX scores of this study contained several negative values, so they underwent a type of pre-processing that consisted in a normalization operation that rescaled the scores to a unified scale of positive values, to facilitate statistical analysis. Scores, thus, seemed higher than they were, but the data set conserved all its original characteristics.

To test hypothesis (i) a paired-sample t-test was conducted. This test compares the means of two measurements taken at two different times (here, before and after treatment) (Gall & Borg, 1989). The

two assumptions of the continuous dependent variable and categorical independent variable data were met. Next, tests for outliers and normality were run. Inspection of a boxplot, constituted by the respective arithmetic differences between the paired observations of the two groups independently, revealed the absence of outliers. Then the Shapiro-Wilk normality test showed that the "difference" scores for the pre- and post-tests CT data were normally distributed (p = .641).

3. Results

Assumptions being met, the paired-samples *t*-test was run. Descriptive statistics showed that the undergraduates of the experimental group scored higher in the CT post-test (M = 50.01, SD = 10.94) than in the pre-test (M = 42.33, SD = 10.21). The paired-sample *t*-test revealed that the course-attending group showed a statistically significant mean increase of 7.68, 95% CI [5.48, 9.87], t (39) = 7.086, $p < .001$ in the CT post-test compared to the pre-test. The effect size for this analysis (d = 1.12) was found to exceed Cohen's (1988) convention for a large effect (d=.80). Thus, there was a statistically significant difference between experimental groups' means (p < 0.05); and therefore, the null hypothesis can be rejected and the alternative hypothesis (*i*) can be accepted (Table 1).

Table 1

Paired Samples T-Test Results

| | Paired Differences | | | | | | | |
| | | | | 95% Confidence Interval of the Difference | | | | |
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Two-Sided p
Experimental Post-test - Experimental Pre-test	7.68150	6.85571	1.08398	5.48894	9.87406	7.086	39	<.001

To test hypothesis (*ii*), a one-way ANCOVA was performed. It tests the existence of any statistically significant difference between the population means of independent variable conditions (here, experimental and control), after adjusting for the covariate (the pre-test data). This is the most appropriate test to address the main threat to internal validity caused by the lack of random sampling in quasi-experimental designs (Gall & Borg, 1989).

All the required ANCOVA assumptions were met. Concerning homogeneity of regression slopes, the interaction term was not statistically significant, F (1, 62) = 0.000, p = .996. The Shapiro Wilk's normality test indicated that standardized residuals for the CT post-test scores were normally distributed (p=.872, and p=.817 for the experimental and control groups respectively). The one-way ANCOVA was then run. Adjusted descriptive statistics results (estimates) showed that the CT scores mean was greater in the experimental group (*M* = 47.61, *SE* = 1.14) compared to the control group (*M* = 41.63, *SE* = 1.43).

To see whether the experimental and control groups' CT means were significantly different, the one-way ANCOVA revealed that, after adjustment for the pre-course test, there was a statistically significant difference in post-course test score means between the control and experimental groups, F (1, 63) = 10.018, p = 0.002, partial η^2 = .137. The results are displayed in Table 2 below:

Table 2

One-way ANCOVA results

Dependent Variable: POST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6916.407[a]	2	3458.203	69.277	<.001	.687
Intercept	492.571	1	492.571	9.868	.003	.135
PRE	4618.220	1	4618.220	92.516	<.001	.595

GROUP	500.060	1	500.060	10.018	.002	.137
Error	3144.847	63	49.918			
Total	145269.168	66				
Corrected Total	10061.254	65				

a. R Squared = .687 (Adjusted R Squared = .678)

4. Discussion

Results showed that the course had a statistically significant effect on the CT skills of participants who attended the course, as compared to those of the control group. These findings corroborate the conceptual insights that closely link the two constructs (Bailin, 1999; Kuhn, 1999; Kuhn & Weinstock, 2002; Kuhn & Dean, 2004; Felton & Kuhn, 2007). Results are also supported by empirical studies (Brabeck, 1983; Chan et al., 2011; Mines et al.,1990; Mitchell et al., 2020; Peterson, 1995). Chan et al., (2011), for instance, found that absolutist EBs among Chinese undergraduates predicted poor two-sided reasoning and a tendency to ignore counter-arguments. Mines et al., (1990) also uncovered that students who hold sophisticated EBs demonstrate better CT skills than those with naïve EBs. This, though, supports the positive relation but not causation.

These results might be explained by the course application of several epistemic change techniques that were shown to yield positive results, such as refutational text exposure (Kienhues et al., 2008), ill-structured problem-solving (Kerwer & Rosman, 2018), explicit reflection (Brownlee et al., 2008), to mention but these. Moreover, the constructivist instructional approach implemented in this study provided also advantageous outcomes in previous research about epistemic change (Muis & Duffy, 2013). The impact of this instruction was probably translated into a more alert, critical attitude in the undergraduates. This critical alertness may have helped them, during the CCTTX, in the examination of the provided information and the evaluation of the different choice assertions, and hence in the choice of the most valid.

However, despite the observed statistically significant difference attesting to change, the overall CT scores were considerably low. This may be explained by the fact that English was but a foreign language to these participants, combined with the test length likely resulting in students' weariness. Another explanation is the lack of prior encounter with CT instruction, which might imply an insufficient ability to identify assumptions, premises, etc.

5. Conclusion

Although the participants who attended the treatment course struggled to a certain extent during the CCTTX, their post-test performance did attest to change. A major implication of these results is that epistemically informed, long-term instruction does appear to have the potential of fostering students' CT skills. Adopting this pedagogical approach in all the curricula is possible because of the extensive research in domain-specific PE.

Moreover, the increasingly growing scholarship on epistemic climate is of great value to this endeavor. The epistemic climate is defined as "context encompassing different epistemic factors (…) and processes (…) that interact and influence a person's epistemology". Designing instructional programs informed by research into these epistemic pedagogical factors, along with domain-specific epistemic beliefs would provide precious help towards fostering CT across the curriculum.

Nonetheless, as this study seems to conclude, *explicit* CT instruction is also needed. The epistemological understanding was indeed shown to help understand the nature and finality of CT performance. Nevertheless, it appears that the technical components of the CT cognitive operations *per se* can better be provided by explicit pedagogy.

One limitation of this study is the lack of random sampling, which weakens claims of causality. Another limitation is the lack of intermittent measuring of change, which would have provided important insights into the mechanisms that led to the observed findings. A third limitation concerns generalizability. This research was conducted in one small community and has no generalizability claims. Thus, further research is needed to test the findings of this study in various settings, while addressing its limitations.

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