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The Impact of an Information System Curriculum on Actual and Perceived Critical Thinking

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IMPACT OF AN INFORMATION SYSTEMS CURRICULUM ON CRITICAL THINKING IN A BUSINESS COLLEGE

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ABSTRACT

Critical thinking has been recognized as important in information systems curricula, yet there is little published research objectively assessing how it can be most effectively taught. This paper presents the results of an exploratory study of the impact of a curriculum designed to teach critical thinking within the information systems discipline. Additionally, the impact of the curriculum on students' self-evaluation of their own critical thinking skills is demonstrated.

Keywords

Critical thinking, IS curriculum, curriculum design, assessment

INTRODUCTION

Accrediting bodies, employers, and business colleges emphasize the importance of critical thinking for college graduates (AACSB, 2020; Wall Street Journal, 2010). Although it is generally agreed that critical thinking can be taught (Ennis, 2018), the impact of college on critical thinking is inconclusive (Huber & Kuncel, 2016). Critical thinking has been recognized as fundamental for undergraduate information system (IS) majors (Association for Computing Machinery & IEEE Computer Society, 2021), yet there has been limited study about how critical thinking skills are best taught in IS programs (Matthee & Turpin, 2019) or how to successfully assess those skills.

LITERATURE REVIEW

There are numerous definitions of critical thinking. However, most agree that critical thinking includes skills and abilities, as well as the disposition to apply them (Halpern, 1998; Willingham, 2019). In business education research, critical thinking has been defined as the ability to evaluate sources of information, challenge assumptions, understand context, analyze arguments, and use metacognition (Brown & Bielinska-Kwapisz, 2015). The development of critical thinking requires hard work and time (Paul & Elder, 2001). Although critical thinking skills can be taught, many students do not want to apply effort to learning or to critical thinking (Franklin et al, 2022).

Teaching Critical Thinking Skills

Disagreement exists about whether critical thinking abilities are generalizable skills that can be transferred to new contexts or are domain dependent (Willingham, 2019). Although critical thinking skills are normally embedded in discipline-specific courses, some business colleges include courses specifically created to teach critical thinking skills. Embedding critical thinking skills in a course can be implemented in two ways: immersion and infusion approaches (Ennis,1989). The immersion approach is based on the idea that critical thinking processes are inseparable from domain knowledge. Assignments and pedagogy believed to improve critical thinking skills, such as case studies, writing assignments, and peer feedback, are used to teach critical thinking in that discipline; however, critical thinking concepts and principles are not explicitly taught (Ennis,1989). In the infusion approach, critical thinking skills are explicitly taught within the structure of the discipline, through direct instruction, scaffolding, and practice (Ennis, 1989).

In the generalist approach, critical thinking abilities, skills, and motivations are taught apart from a specific discipline in a separate course or module. This is based on the belief that critical thinking skills are generalizable and transfer across disciplines and contexts. In a program, the generalist method may be combined with either the infusion or immersion approach. The immersion approach has been the most used in all academic disciplines (Puig et al., 2019; Tiruneh et al., 2014).

Studies of the effectiveness of each of these approaches have mixed results. Some have found the mixed approach is most effective and the immersion approach the least (Cáceres et al., 2020), while others identified the generalist and mixed approaches as most effective (Tiruneh et al., 2014). Studies have found that the generalist approach may not yield transferrable

knowledge (Willingham, 2019), while others found that domain-specific instruction using the immersion or infusion approaches may not yield transferrable critical thinking skills (Tiruneh et al, 2018).

Assessing Critical Thinking Skills

It remains unclear how to best measure critical thinking skills in the classroom (Possin, 2008). Most standardized instruments measure general critical thinking skills that are considered transferrable, such as deductive and inductive reasoning and interpretation and inference skills, using a multiple-choice format (Possin, 2008). The California Critical Thinking Skills Test (CCTST) has often been used to study the effectiveness of critical thinking instruction (Ågerfalk et al., 2017; Whitten & Brahmasrene, 2011). The Business Critical Thinking Skills Test (BCTST) is a version of the CCTST designed to test critical thinking in a business context. Most studies of pedagogical interventions in IS have used instructor-designed assessments or instructor or student perceptions (e.g. Davis et al., 2006), while few have used standardized critical thinking instruments (Ågerfalk et al., 2017).

Assessment type affects assessment results. Studies using researcher- or instructor-designed assessments have found significant improvement in critical thinking almost twice as often as those using standardized instruments (Tiruneh et al., 2014). Students assess their own critical thinking in some studies (Davis et al., 2006); yet, individuals may not accurately assess their own abilities (Iglesias Pérez et al., 2022; Kruger & Dunning, 1999; Roohr & Burkander, 2020).

Self-Assessment of Critical Thinking Skills

An important aspect of critical thinking is the ability to evaluate one's own reasoning (Paul & Elder, 2001). Some consider metacognition, the awareness and understanding of one's thought process (Miriam-Webster, n.d.) to be the most fundamental critical thinking skill (Schoenberg, 2015). Elder and Paul (1996) identify six stages of critical thinking development, ranging from unmindful thinkers unaware of standards for thinking and of problems in their reasoning, to expert thinkers to whom critical thinking, including self-assessment, is intuitive. They note that, in the early stages, thinking skills that individuals have unconsciously developed may slow the development of critical thinking, since the individuals may believe their thinking is better than it is.

Kruger and Dunning (1999) found that individuals who are unskilled in an area lack metacognition and overestimate their abilities and performance, since the skills needed to be competent in an area are generally the same as those needed to judge competence in that domain - the Dunning-Kruger effect (Pennycook et al., 2017). After additional training, both low and high performing individuals have been found to more realistically assess their abilities (Kruger & Dunning, 1999). Overconfidence in one's abilities has been seen in both skilled and unskilled individuals, although individuals who perform well generally assess their skill more accurately (Simons, 2013) and may even underestimate their abilities and performance (Kruger & Dunning, 1999). This has implications for the effectiveness of self-reported measures of thinking (Pennycook et al, 2017).

RESEARCH QUESTIONS AND DATA COLLECTION

To investigate how to successfully teach and assess critical thinking skills, we studied the impact of an IS curriculum using the immersion approach on the critical thinking skills of IS majors and their ability to assess their own thinking.

Background

Our IS program resides in an AACSB-accredited college of business. Critical thinking skills have been regularly assessed as a student learning outcome throughout the college, including in the IS program, using a university-wide rubric. In 2019, the IS faculty revised the approach to teaching and assessing critical thinking in the IS curriculum to implement the immersion approach to critical thinking – that is, to redesign assignments of IS core courses, such as projects and papers, to target improvement in critical thinking skills. The IS faculty coordinated the inclusion of research papers, case studies, and realistic projects designed to foster critical thinking skills in required IS courses. The faculty believed that students would improve critical thinking skills by completing assignments designed to promote critical thinking, especially when assignments and grading rubrics emphasized elements of critical thinking.

Research Propositions

To investigate the impact of the immersion approach to teaching critical thinking in IS on students' generalizable critical thinking ability, as well as the influence of its effect on the accuracy of students' evaluation of their own critical thinking skills, the following research propositions were developed based on the studies discussed above, particularly (Elder & Paul, 1996; Kruger & Dunning, 1999; Tiruneh et al, 2018).

> P_1: After completing an IS curriculum teaching critical thinking through immersion, IS seniors will demonstrate higher critical thinking skills than juniors who have not completed the program.

P_2: IS seniors who complete an IS curriculum teaching critical thinking through immersion will realistically estimate or under-estimate their critical thinking ability and juniors who do not complete the curriculum will overestimate their ability.

P_3: Students with high critical thinking skills will realistically estimate or under-estimate their critical thinking ability and students with lower critical thinking skills will overestimate their ability.

P_4: Seniors who complete the IS curriculum and have high critical thinking skills will realistically estimate their critical thinking ability more often than will juniors with high critical thinking skills who do not complete the curriculum.

Data Collection

The BCTST was used to objectively measure general critical thinking skills, since it is based on a widely accepted definition of critical thinking (Facione, 1990), considered a strong assessment instrument (Possin, 2008), and measures dimensions of critical thinking important for IS majors, including analysis, inference and numeracy (Association for Computing Machinery, 2020; Matthee & Turpin, 2019). The BCTST presents brief business scenarios and asks respondents to make a reasoned judgment, but it does not test business content knowledge. Validity and reliability of the BCTST have been documented (Insight Assessment, 2021). The BCTST is administered online and automatically scored by Insight Assessment. Score reports include an individual's overall critical thinking score, a qualitative descriptor of the overall score, and a percentile score comparing students to a benchmark group of undergraduate business students. In this study, the percentile score and semantic descriptor were used to measure critical thinking ability.

The qualitative descriptors are based on the BCTST overall score which ranges between 50 and 100 points (Table 1). Superior overall scores (92 and above) are earned by approximately 12% of the total population of undergraduates in U.S. business programs (Insight Assessment, 2021).

Descriptor	Score	Meaning[1]
Superior	≥ 92	Critical thinking skills are superior to the vast majority of test takers.
Strong	85-91	Critical thinking skills are superior to most test takers.
Moderate	79-84	Critical thinking skills are comparable to average test takers.
Weak	73-78	Weak overall critical thinking skills.
Not Manifested	50-72	Very weak or no critical thinking skill; low effort or reading or language issues.

[1]Based on descriptions in (Insight Assessment, 2021).

Table 1: BCTST Qualitative Descriptors Based on Overall Score

To measure the accuracy of students' perceptions of their critical thinking skills, students were asked to answer "What score do you think you can earn in this test? 100 is the highest and 50 is the lowest." by selecting one from five options based on the qualitative descriptors they believed their score on the BCTST would be: Superior (92 or higher), Strong (85-91), Moderate (79-84), Weak (73-78) and Very Weak (50-72). "Not Manifested" in the qualitative descriptors was replaced by "Very Weak".

The BCTST was administered to an IS class normally taken as the first class in the IS core at the start of the junior year (Mobile App Development) and to a capstone IS class taken by graduating seniors in their final semester (Capstone). As motivation to do well, students were told they would receive extra credit for completing the assessment, based on the score they received. During the semesters between the two courses, IS majors complete the core courses required for the IS program, and, since most withdrawals from the major occur before the junior year, focusing on juniors and seniors lessened the impact of attrition on the results (Liu et al, 2021).

The BCTST is given in 50 minutes; the publisher recommends that scores of people who finish in under 15 minutes be removed (Insight Assessment, 2021). Students in this study completed the test in 18-50 minutes, with a mean time of 37.4 minutes. Time spent on the test was not correlated with critical thinking scores.

RESULTS

The first proposition – that seniors' critical thinking ability after completing the IS curriculum will be higher than juniors' at the start of the curriculum -was tested by comparing the BCTST mean percentile scores of juniors and seniors. As shown in

Table 2, seniors scored in a higher percentile than did juniors. The result was significant (t= -1.95, p = .027), supporting the proposition (P1).

	N	Mean Percentile	SE Mean
Juniors	32	56.66	4.88
Seniors	52	67.56	3.20

Table 2: Mean Percentile Scores

Whether juniors would overestimate their critical thinking ability more than seniors who had completed the IS curriculum (P2) was investigated by comparing students' self-estimates of how well they performed on the BCTST to their actual performance, using the qualitative descriptors. As shown in Table 3, while 34% of juniors overestimated their performance, 23% of seniors overestimated their performance. Additionally, a higher percentage of seniors (46%) accurately estimated their performance than did juniors (28%), supporting P2. The underlying data for Table 3 is available on request.

	Juniors	Seniors
Overestimate	34% (11)	23% (12)
Underestimate	38% (12)	31% (16)
Accurate estimate	28% (9)	46% (24)

Table 3. Ratios among Overestimate, Underestimate and Accurate Estimate

To assess whether students with lower critical thinking ability would inflate their perceived ability and that the estimates of those with higher ability would be realistic or underestimated (P3), all students were classified into two groups based on their BCTST percentile score. Students scoring in the 70th percentile and above comprised the "High" group; the remaining were the "Low" group. As can be seen in Table 4, less than 10% of students scoring in the 70th percentile and above overestimated their critical thinking, while 44% of students scoring below the 70th percentile overestimated, supporting P3. Data underlying tables 4 and 5 available on request.

	Low: < 70th %-tile (n=48)	High: ≥ 70th %-tile (n=36)
Underestimate	21% (n=10)	50% (n=18)
Accurate estimate	35% (n=17)	44% (n=16)
Overestimate	44% (n=21)	6% (n=2)

Table 4. Comparison of Low and High Groups

To examine P4, that after completing the IS curriculum high-scoring seniors would more realistically estimate their abilities than high-scoring juniors, the data in Table 4 was analyzed by class. As shown in Table 5, 52% of low-scoring juniors overestimated their critical thinking abilities, while only 37% of low scoring seniors did so. Additionally, 52% of high-scoring seniors accurately estimated their scores, while only 27% of high-scoring juniors did, supporting P4, indicating that the IS curriculum may have improved students' ability to accurately estimate their critical thinking ability.

	Juniors		Seniors	
	Low (n=21)	High (n=11)	Low (n=27)	High (n=25)
Avg BCTST Percentile score	41.1	86.5	49.2	87.4
Under-Estimated	19% (n=4)	73% (n=8)	22% (n=6)	40% (n=10)
Accurately estimated	29% (n=6)	27% (n=3)	41% (n=11)	52% (n=13)
Over-estimated	52% (n=11)	0% (n=0)	37% (n=10)	8% (n=2)

Table 5: Comparison of Low and High Groups of Seniors and Juniors

CONCLUSIONS AND IMPLICATIONS

Due to the small sample, this study attempts only to evaluate the potential of an immersion approach that is widely used in many IS curriculums to improve IS students' general critical thinking skills. The BCTST was used to objectively measure general critical thinking skills. The results show that the immersion approach demonstrates potential to improve IS student's general critical thinking skills, since senior IS students performed better on the BCTST than did juniors.

Furthermore, as metacognition skills are considered to be key to critical thinking, this study investigated whether an IS curriculum using an immersion approach could improve students' ability to accurately estimate their critical thinking. The

results show (1) More students with higher critical thinking skills accurately estimated their critical thinking skills than did students with lower critical thinking skills; (2) More senior IS students estimated their critical thinking skills accurately than did juniors, and (3) More senior IS students with higher critical thinking skills accurately estimated their critical thinking skills than did junior IS students with higher critical thinking skills, while fewer senior IS students with lower critical thinking skills overestimated their critical thinking skills than did juniors with lower critical thinking skills. Therefore, the study demonstrates the potential of the widely used immersion approach to improve students' critical thinking skills, and also indicates that caution should be used when self-evaluation is used to assess the results of critical thinking interventions.

The immersion approach may have practical advantages over the infusion and generalist approaches. Since the immersion approach does not use class time to teach critical thinking concepts explicitly, while the infusion approach does, ISinstructors do not need to sacrifice any coverage of IS concepts. Additionally, immersion does not require a course dedicated to teaching critical thinking as the generalist approach does, thus additional faculty resources are not needed. By demonstrating the potential of an immersion approach with objectively measured data, IS curricula can use it with more confidence.

LIMITATIONS AND FUTURE RESEARCH

The immersion approach used in this study impacted overall critical thinking abilities as measured by the BCTST. This contradicts assertions that domain-specific instruction in critical thinking fails to improve generalizable critical thinking abilities (Tiruneh et al., 2018). However, this was a cross-sectional study, the BCTST was given as an extra-credit assignment, and data were collected from a small convenience sample in a single IS program, limiting generalization of the results. Although the immersion approach to teaching critical thinking in IS was supported, studies using a larger sample and greater controls is warranted. Additionally, further research on the impact of the Dunning-Kruger impact on the use of self-evaluations of the impact of pedagogical interventions should be further investigated.

Since the ability to use critical thinking both in society and in an IS career is key, how best to improve and assess critical thinking skills in IS programs is a crucial area for further study.

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