NURTURING A CRITICAL THINKING DISPOSITION

IN THE SCIENCE CLASSROOM

by

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ABSTRACT

A Critical Thinking Disposition (CTD) refers to the tendency of an individual to approach problems with curiosity and a desire to learn more in order to make decisions based on reason. This paper summarizes a review of the literature on the importance of developing a CTD as well as strategies for developing critical thinking disposition in the classroom. Twenty-six studies were analyzed which looked at the connection between developing a critical thinking disposition and various life skills (academic achievement, occupational skills, personal well-being and societal benefit) and each was given a positive, negative, or neutral rating based on the results of the study. When combined, it was found that both academic achievement and occupational skill development were linked to a well-developed critical thinking disposition. There was also some evidence that a critical thinking disposition can benefit society as a whole by reducing bias and increasing one's ability to make sound judgments, but this needs further investigation. Interestingly, there was evidence that a critical thinking disposition can have a negative effect on mental health, particularly in the areas of anxiety, although further research is needed to confirm this connection. In order to identify effective techniques for teachers to help students develop a critical thinking disposition, thirty-eight studies were examined for specific strategies that have been used in the classroom and whether these were effective. These methods were overwhelmingly successful and a compilation of strategies was developed to provide teachers with a number of possible ways this can be incorporated with their classes. Current literature supports the theory that a critical thinking disposition is an important part of a student's education and needs to become a greater focus in the classroom, with activities combining the development of these skills with the teaching of core content.

INTRODUCTION AND BACKGROUND

Introduction

In the Fall of 2008, I had the opportunity to take a leave of absence from my position as a junior high school science teacher to live and work in a remote region of northern Ghana. My job was to conduct workshops for local math and science teachers demonstrating the use of activities in the classroom to enhance student learning. To prepare myself for my trip, I purchased a mosquito net in Canada so that I would have it available immediately upon arrival at my new home in order to protect me from the threat of malaria. Although my mosquito net was a different design than the ones used by locals, I was reassured that it would be hung for me by a couple of workers at the guesthouse I lived in while I was at work on my first day. When I arrived home, I was surprised to find the string holding my mosquito net was hanging from the ceiling in the midst of the blades of the ceiling fan. The net had been cut off when the fan was turned on. The workers approached me, stating that they had not been able to hang the mosquito net successfully and were waiting for me to return to see if I had any ideas on how to fix this. This particular event has stuck with me for many years, influencing both my teaching as well as in my role as a parent, for two reasons. Firstly, it was quite shocking to me that having the string hanging down within the blades of the fan was not an apparent problem until after the string was severed. Secondly, it was disheartening that these individuals did not attempt to come up with alternative solutions and chose to wait for me to come up with ideas.

After returning from Ghana, I moved to teaching Biology at a large, academic high school in Calgary, Alberta. Calgary has a population of approximately 1.4 million people and is

known as a hub for oil and gas corporate activity and the home to a significant number of corporate head offices (Government of Canada, 2021). Although there has been considerable employment uncertainty due to the singular focus of the industry within Calgary, the median annual family income is high ($105 000 CAD) and relatively stable. The number of people who identify as a visible minority has doubled in the past twenty years, now representing 36% of the total population, and over half of the adult population holds a college diploma or university degree. Within my classroom, there are a large number of students who are singularly focused on achieving high marks rather than on progression of learning. In discussions with them, they often express a fear of disappointing their parents or not gaining admission to their desired post-secondary program if they don't get a high enough overall grade. They are less interested in ensuring that they are developing the knowledge and skills they will need in order to become successful professionals in the future.

<u>Background</u>

In his book *Intellectual Character*, Ron Richhart (2002) questions the purpose of modern education and challenges the reader to consider his ultimate vision for teachers as "shapers of students' intellectual character" (p. 9). He emphasizes the importance of not only equipping students with the ability to think, but also nurturing the development of the habit, or disposition, of thinking in students. Richhart notes that dispositions of thinking are not innate but must be both acquired, such that they develop these capabilities, and practiced, in order to become a consistent behavioral response. The focus of this paper will be to describe the characteristics of a disposition of thinking and why a critical thinking disposition is important. There will be a discussion of how a critical thinking disposition can be taught effectively including how current

teaching falls short of achieving this ideal. Finally, I will examine the research into how a critical thinking disposition impacts both a student's achievement and well-being, specifically in the areas of resilience and mental health.

<div align="center">Focus Questions</div>

My focus question was, What is a critical thinking disposition and why is this a significant aspect of student education?

My sub-questions include the following:

1. What are the effects of a critical thinking disposition on students?

2. How is a critical thinking disposition nurtured in the students?

CONCEPTUAL FRAMEWORK

What is a Critical Thinking Disposition?

The concept of a critical thinking disposition integrates two significant components; the skills and knowledge for critical thinking and the internal motivation or inclination to consistently use these skills. Simply put, a critical thinking disposition is seeing intelligence in action (Richhart, 2004). A brief discussion of each of the facets is necessary before looking at them as a whole.

Over the past thirty years there has been considerable focus within the academic community on the need for critical thinking skills in all levels of schooling. The publication titled "A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction," commonly referred to as the Delphi Report, was published in 1990 and contains a comprehensive overview of the research into critical thinking conducted up until that time (Facione, 1990). The Delphi Report utilized the Delphi research method which combines the experience of a number of independent experts in order to strengthen the validity of the conclusions while reducing errors that can occur from individual responses (Bhattacharya, 2017). In this method, numerous experts in the field are asked to respond to a set of questions anonymously. These responses are then combined by the primary researcher and presented back to the group. Respondents can modify their responses and resubmit before the final aggregation is produced. This method allows for many experts in a given field to contribute to the research and benefits from the free flow of ideas due to the anonymity of responses.

The purpose of the Delphi Report on Critical Thinking was to bring together experts in the field from a number of different backgrounds to come to a consensus on which skills are

necessary for critical thinking, how critical thinking skills can be assessed and the importance of including critical thinking skills within content-specific curricula (Facione, 1990). Despite a significant passage of time, it continues to be referenced to this day. The Delphi Report identified the key critical thinking skills as: interpretation, analysis, evaluation, inference, explanation and self-regulation. These skills enable an individual to explain solutions, provide alternatives, distinguish fact from opinion, and draw inferences (Buskist & Irons, 2008). Both the process of thinking, and the overall outcome, are critical. Critical thinking is thinking that is purposeful, reasoned and goal-directed.

The Oxford Dictionary defines disposition as a person's inherent qualities of character and mind. Disposition represents the internal motivator of actions or responses to the world, a tendency to behave in a particular way (Ritchhart, 2004). Having a particular disposition does not mean that one automatically behaves in this way at all times without thought, as with a habit, but rather tends to "nudge" one towards a particular behavior.

Put together, a critical thinking disposition (CTD) is the consistent internal motivation to engage problems and make decisions by using thinking (Facione et al., 1995). A CTD is the innate drive to seek the logic of things matched with the skills to do so (Paul & Elder, 1999). An individual exhibiting a critical thinking disposition shows a habitual willingness to engage in complex tasks. They possess the flexibility and willingness to abandon strategies which are non-productive and are aware of the realities of working with others, such as the need for consensus (Halpern, 1998). A CTD enables thoughts to become actions; this requires both the ability and inclination for metacognition, the monitoring of one's own thinking process, in order to

continually monitor one's progress. A critical thinking disposition is strategic, planful, anticipatory, methodical and careful (Ritchhart, 2004).

One of the key findings which came out of the Delphi Report was the consensus that much more research needed to be done with regards to the disposition to think critically, as simply possessing the skills to think critically is ineffectual if an individual does not apply these skills (Facione, 1990). Further research following the publication of the Delphi Report led Facione to develop the commonly used California Critical Thinking Disposition Inventory (CCTDI) (Facione & Sanchez, 1994). The CCTDI is an assessment tool still widely used around the world to assess an individual's current level of disposition to value and use the critical thinking skills they possess. Facione identified seven subcategories of reasoning skills that are necessary for reflective decision-making. These are: inquisitiveness, systematicity, analyticity, truth-seeking, open-mindedness, critical thinking self-confidence and maturity (Table 1).

Table 1: Critical thinking disposition subscales identified in California Critical Thinking Dispositions Inventory (Facione 1994)

Subscale	Description
Inquisitiveness	Intellectual curiosity and desire for learning.
Systematicity	Tendency towards organized, orderly, focused and diligent inquiry.
Analyticity	Application of reasoning and the use of evidence to resolve problems, anticipating conceptual or practical difficulties, and consistently being alert to the need to intervene.
Truth-seeking	Eagerness to seek the best knowledge in a given context, courageous about asking questions, and honest and objective about pursuing inquiry.
CT Self-Confidence	Trust in one's soundness of judgement and ability to lead others in the resolution of problems.
Maturity	Judiciousness in decision-making.
Open-mindedness	Tolerance of divergent views with sensitivity to the possibility of one's own bias.

The skills identified as belonging to a critical thinking disposition differ from the set of cognitive skills that were described as critical thinking skills in the Delphi Report (Facione, 1990). These skills include interpretation, analysis, evaluation, inference, explanation, and self-regulation. Facione et al. (1995) clearly outlined the idea that simply possessing critical thinking skills, yet not using these skills, will not be enough to call someone a critical thinker. Much focus has been placed on integrating the development of critical thinking skills into educational programs with dispositional aspects being neglected up until this time.

Why is a Critical Thinking Disposition Important?

In his discussion of professional judgment, Facione points out that a significant number of errors in judgment occur in the workplace (Facione et al., 1995). These errors can be both costly and have a serious impact on the health and safety of employees. These errors often occur not due to a lack of ability to make the right decision, but the unwillingness of individuals to consistently use the skills they possess. Professional judgement is critical thinking exercised in a practical, professional setting. In addition to the need to avoid costly or dangerous mistakes, apathy in this area is also linked with intellectual dishonesty and an ambivalence toward seeking the truth. There is also evidence that shows that not only knowledge, but also the skills taught in a classroom, are not retained once a student is no longer in the environment (Ritchhart, 2004). It is the patterns of thinking, and the inclination to do so, which persist.

A CTD is also critical in avoiding pseudoscientific thinking (Halpern, 1994). This is particularly important with the increased volume and availability of information to the average person through social media (Seale, 2020). Gu and Feng (2021) studied responses to the COVID-19 pandemic and identified the importance of scientific information literacy (SIL) as a means of reducing individual susceptibility to science-related misinformation. Scientific information literacy essentially created a shield to scientific misinformation in the media. They defined scientific information literacy as "the ability to practice critical thinking based on scientific evidence, reasonable analysis, as well as the consensus of the scientific community, which leads to the recognizing of science-related misinformation." The importance of scientific information literacy has never been more apparent than in the public response to the COVID-19 pandemic that has resulted in over six million lives lost worldwide to date and immeasurable impacts on

health, well-being and the global economy (Johns Hopkins University, 2022). Exposure to misinformation was found to make individuals more vulnerable to the virus by discouraging the use of effective protective measures, encouraging the use of ineffective or harmful treatments, incorrectly identifying the way the virus can be transmitted and downplaying the risks associated with the pandemic (Hansson, 2021). A critical thinking disposition plays a significant role in ensuring individuals are able to respond sensibly to unforeseen, novel circumstances.

What Is Lacking in Current Teaching of Critical Thinking?

Many teachers can attest to the disconnect between the ideal of the teacher as the shapers of intellectual character and the current situation in our classrooms (Ritchhart, 2004). Even in the most "successful" classroom with students focused and working diligently to complete assigned tasks, the focus of these classrooms is on task completion rather than on the learning that is occurring. There is pressure to fill our students up with knowledge and specific skills, even though these have a "short shelf-life" compared with the traits developed by students while in the classroom.

Effort and knowledge are emphasized rather than thinking. This is evident when teachers are challenged by parents and administration about their methods of assessment. For example, my students often ask for a list of all of the topics that could be on an assessment. They express that it is "unfair" to be given novel information and asked to use their skills to work through solving a problem if this could negatively affect their grade. The school board I work with has also moved to using outcomes-based assessment. Students can only be assessed on their demonstrated understanding of specific outcomes identified in the curriculum, most of which are knowledge based. For example, the foundations of the Biology 20 (grade 11) course in Alberta

there are clearly defined attitude, knowledge and skill outcomes (Government of Alberta, 2016).

However, the outcomes-based assessment procedure outlined by my local school board has only

20% of a student's mark reflect the attainment of these skills while 80% is based on achieving

knowledge outcomes. Assessing attitudes toward science are omitted from this outcomes-based

assessment. Teachers have expressed frustration that, unless a given activity or task is "for

marks," their students put little effort into the activity, missing out on rich learning opportunities.

There is a noticeable gap between ability and action, which can only be closed by emphasizing

and nurturing a critical thinking disposition in our youth (Perkins, 2000; Ritchart, 2004).

A critical thinking disposition integrates both the skills to think critically and the

inclination to do so. It is an important aspect of any educational system as a CTD is imperative

for achieving success in both academics and the workplace. Much of the focus of the

development of critical thinking skills up to this point has been about the cognitive skills

necessary to tackle complex problems. It is now becoming clear that the dispositions necessary

to apply these skills need a greater focus within our education systems.

METHODOLOGY

A preliminary search of the MSU library database for peer-reviewed journal articles containing the term "critical thinking disposition" in the description yielded over 1600 journal articles. This list was narrowed down by looking for articles that were specific to education and learning, and a final list of 130 articles was selected. These articles were then divided into categories based on whether they focused mainly on what a CTD is, why teaching a CTD is important, how a CTD can be assessed and ways in which a CTD can be taught in the classroom.

Of the 130 original journal articles, 26 were deemed to include research into the importance of a critical thinking disposition (Appendix A). These articles were all published after 2000, included sample sizes of at least 60 (with the exception of one study including qualitative data collected by interview), and used either published assessment tools or researcher-generated assessments which cited published assessment tools for reference (Figure 1).

Criteria for Inclusion of Studies for Analysis in this Research

- Specific to education and learning
- Published since 2000
- Included sample size of at least 50
- Used or referenced published CTD assessment tools

Categorization of Studies for Analysis in this Study

Impact of a Critical Thinking Disposition
- Occupation Skills
- Academic achievement
- Personal well-being
- Societal benefit

Teaching Techniques
- Specific strategies described
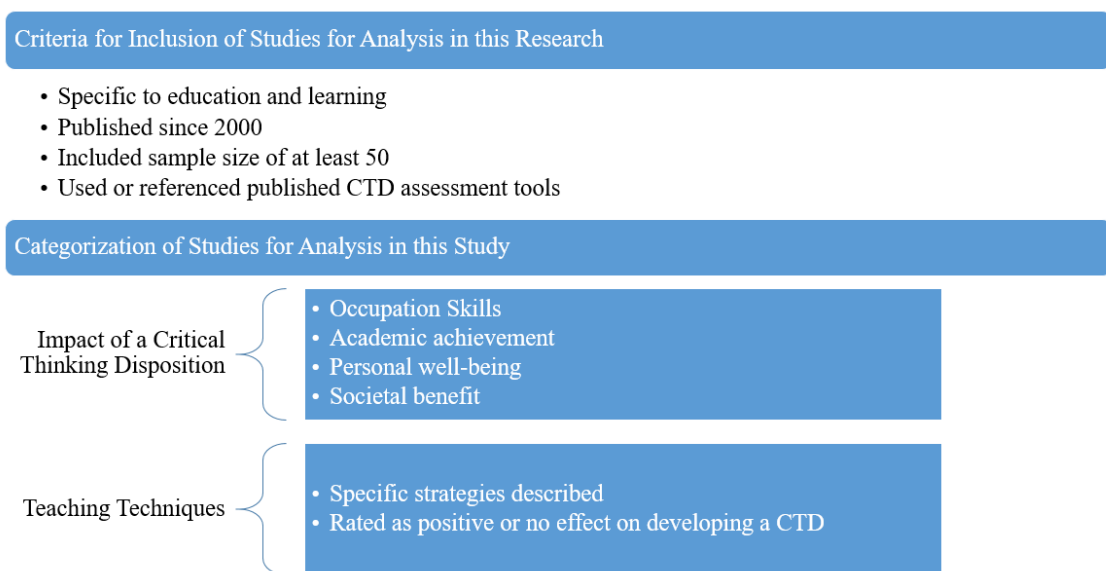- Rated as positive or no effect on developing a CTD

Figure 1 Summary of the criteria for inclusion of research studies for analysis

The key findings of each study were classified under one of the following categories: Occupation skills (professionalism, evidence-based problem solving in the workplace, research competence, self-efficacy, moral sensitivity, and employability), academic achievement (meeting learning objectives, learning behaviors, achievement scores, course or degree completion), personal well-being (mental health, resilience, self-confidence, and career satisfaction), and societal benefit (avoiding misconceptions, pro-social behaviors, disaster preparedness). The majority of studies into the importance of a critical thinking disposition (n=17) involved research at a post-secondary institution, while six involved professionals from various occupations, two from the general public and one from secondary education. One study had significant findings in two areas and therefore appears in two categories. Each study was assigned a contribution factor of +2, +1, 0, -1, or -2 to reflect the strength of the findings. In order to compare the relative significance towards each category of benefit, the total of the contribution factors was divided by the number of studies included.

In order to identify effective strategies for developing a critical thinking disposition in students, 38 studies were identified (Appendix B). All of these studies were published after 2000, involved studies with a minimum of 50 individuals, used either published assessment tools or researcher-generated assessments which cited published assessment tools for reference. Four articles provided a meta-analysis of other research, 26 studies were with post-secondary students and eight were involving K-12 education. Most studies mentioned specific interventions and therefore this data was compiled into a concept map which reflected the frequency with which each treatment was discussed.

DATA ANALYSIS

Results

What are the Effects of a Critical Thinking Disposition on Students?

Studies into the importance of developing a critical thinking disposition focused largely on occupational skills ($n=10$) and academic achievement ($n=8$) while fewer looked at the personal well-being ($n=5$) and societal benefit ($n=4$) of developing a critical thinking disposition (Table 2; Figure 2).

Table 2: Summary of the effects of a critical thinking disposition by category

Category	Number of Studies	Overall Rating[1]	Relative Significance[2]
Occupational Skill	10	+14	+1.4
Academic Achievement	8	+9	+1.1
Personal well-being	5	-2	-0.4
Societal benefit	4	+4	+1.0

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[1] Each study was assigned a contribution factor of +2, +1, 0, -1, or -2 to reflect the strength of the findings. Overall rating was calculated by adding together the contribution factor for each study in each category.
[2] The relative significance was calculated by taking the total of the contribution factors divided by the number of studies included.
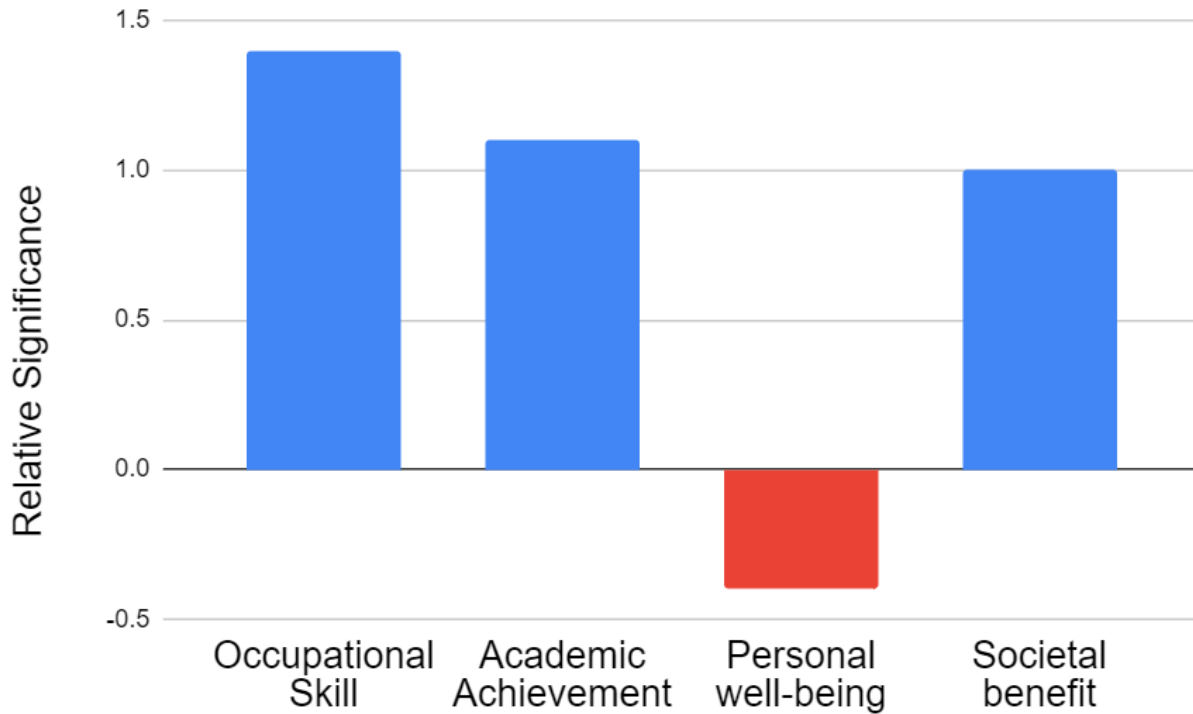
Figure 2: Summary of the effects of developing a Critical Thinking Disposition by category, (N=27).

In general, the greatest benefit from CTD skill development was found in the areas of occupational skills with all studies except one finding an occupational benefit of a critical thinking disposition. The only study which identified a negative aspect of a critical thinking disposition with respect to occupational skills was specific to nursing and moral sensitivity, the ability to understand the moral consequences of decisions made on behalf of a patient (Ahn & Yeom, 2013). The researchers postulated that this might reflect a lack of experience and instruction on ethics of the nursing students involved in the study at this point in their training. There also appears to be a significant link between academic achievement and the development

of a critical thinking disposition with six of eight studies finding a benefit to academic achievement and no studies finding a detrimental effect on academic achievement. Although it did not appear in the research as often, all studies into increasing moral consciousness in the general population and reducing misconceptions were positively correlated with a critical thinking disposition, suggesting a need for further study in this area.

The area which seemed to identify a negative aspect of developing a critical thinking disposition was in that of personal well-being. Upon further categorization (Appendix B for details of studies), it appears that a critical thinking disposition is correlated with the positive aspect of resilience but also with the negative aspects of anxiety and poor mental health. One study identified that anxiety seemed to be mediated by impulsivity and therefore could be countered by specifically emphasizing development of systematicity and truth-seeking (Liu et al., 2021)

How is a Critical Thinking Disposition Nurtured in Students?

Of the 38 studies into methods to develop a critical thinking disposition in students, thirty found strategies which helped develop a critical thinking disposition while only eight identified strategies which did not result in a significant improvement in critical thinking dispositions relative to the control treatment. Strategies were categorized into four categories: student tasks, classroom environment, instructional strategies, and events beyond the classroom. Figure 3 shows all of the strategies analyzed; green circles identify strategies which were effective in developing a CTD while yellow circles represent strategies which had no significant effect on the development of a CTD. Most strategies researched were very specific and discussed in only one study, but a few were investigated in more than one study. These are represented with larger

circles relative to the number of studies that looked at a particular strategy as well as a number indicating the number of studies which looked at that particular strategy. Overall, problem-based learning (*n*=4), concept-mapping (*n*=3) and direct instruction on critical thinking skills integrated within the content material (*n*=2) were the strategies found to be beneficial in more than one study. Computer games and simulations (*n*=3) as well as mindfulness training (*n*=2) were strategies that were found to have no considerable effect on developing a critical thinking disposition in more than one study.
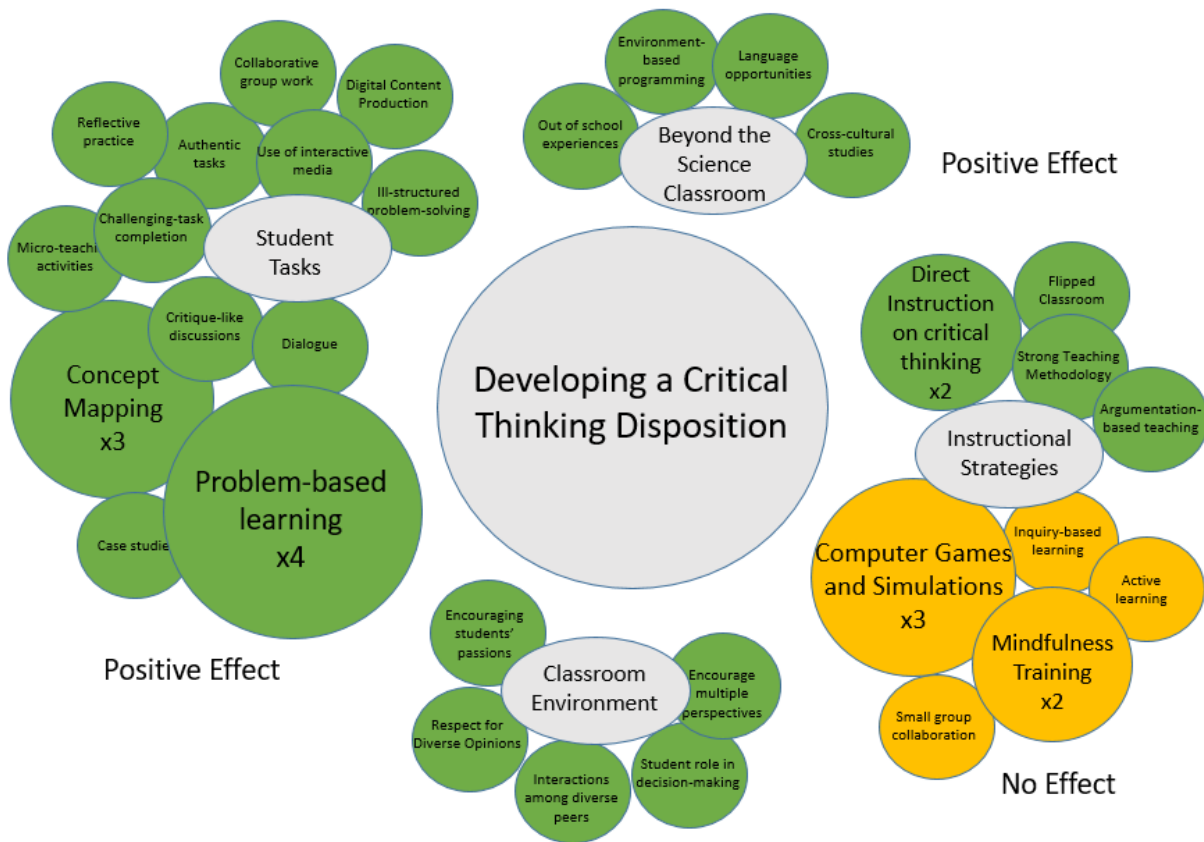
Figure 3: Summary of strategies used to nurture a Critical Thinking Disposition.

CLAIM, EVIDENCE, AND REASONING

The concept of a critical thinking disposition blends the ability of an individual to think critically and the propensity to do so. The focus of this paper was to examine the research conducted over the past twenty years into the effects of a CTD on students and how a critical thinking disposition can be nurtured in students. Based on this research, it was found that the development of a critical thinking disposition is an essential aspect of students' formal education. A CTD offers considerable benefit to the individual and requires rich learning opportunities (see Figure 3). A variety of teaching techniques were found to help students develop a CTD allowing teachers flexibility and autonomy in choosing those which best suit their learners.

Claims From the Study

Claim #1: Critical Thinking Disposition Development is an Essential Aspect of Students' Formal Education

The development of a critical thinking disposition is a necessary part of a young person's educational experience in order to excel in both academics and future careers. As was originally proposed by Facione et al. (1990) in the Delphi Report, it is not just the attainment of the skills to think critically but the likelihood to use them, which have a significant impact on one's success in school and the workplace (Facione, 1990). Research conducted since the publication of the Delphi Report has consistently shown there is widespread benefit from an individual's tendency to use critical thinking skills in the both the classroom and workplace. Six of eight studies looking at the impact of a critical thinking disposition on academic achievement found greater success in students who had a high critical thinking disposition. Academic success does not just reflect the acquisition of knowledge and skills, as is measured by completion of specific

curricular outcomes, but is an important step for students to progress to higher levels of education and career-specific training. Both GPA and a likelihood to complete post-secondary programs increased with the development of a critical thinking disposition.

When looking at success within the workplace, nine out of ten studies which looked at the impact of a critical thinking disposition on occupational skill development found that individuals with a higher critical thinking disposition were better equipped for success in their chosen occupation. This was particularly evident in occupations which required problem-solving and evidence-based decision-making within their role, like medicine and education. Individuals with a critical thinking disposition were more likely to be aware of the need to consider multiple opinions and perspectives while carrying out their roles, which carried over to an overall increase in professionalism.

The development of a critical thinking disposition needs to be a formal aspect of education as it has been found that these dispositions do not develop on their own. Despite having developed the skills to think critically, students often struggle to realize when they should be using these skills and therefore need direct instruction and practice to develop the habitual and sensitive nature of a CTD (Perkins, 2000). Project Zero, based out of the Harvard Graduate School of Education, has identified understanding and nurturing human potentials as their mission and has spawned a plethora of research into thinking and learning (Project Zero, 2022). They have developed over 80 thinking routines which can be used with students to encourage thinking and help students develop a sensitivity to when critical thinking is not only appropriate but necessary.

Claim #2: Critical Thinking Disposition Development can be Furthered
Through the use of Many Different Teaching Methods

The development of a critical thinking disposition is a significant aspect of development

and one on which classroom teachers can have a positive impact, regardless of subject area.

After surveying a total of thirty-eight journal articles, there was no single method for teaching to

improve students' critical thinking dispositions, which indicates two key takeaways for teachers.

Firstly, teachers do not need to feel pressure to employ a particular style of activity or teaching

method in order to benefit students' critical thinking dispositions. There are many strategies that

can help lead to the development of these seven dispositions, and therefore teachers can use

strategies that match their own personal style. Secondly, using any of the specific strategies

outlined does not guarantee successful development of a critical thinking disposition in students

and therefore many such activities need to be included over extended periods of time in order to

be effective. In general, effective strategies are student-centered and require students to take

multiple-perspectives or solve problems that do not have a clear solution. Problem-based

learning, authentic tasks and the use of concept mapping along with intentional instruction on

critical thinking skills were cited most frequently as effective, although numerous other

strategies were shown to contribute to the development of a critical thinking disposition. A

respectful classroom environment which includes diversity in viewpoints, cultures and

experiences was also important for students to feel comfortable fully participating in classroom

activities.

Value of the Study and Consideration for Future Research

The research that has been conducted for this capstone has been meaningful for me personally as it has reaffirmed the idea that it is not just the thinking skills that are necessary to be cultivated in students, but the inclination to make critical thinking a habitual process, a natural way with which they approach all facets of life. Secondly, it has been valuable in identifying for me that a critical thinking disposition does not develop on its own, but needs to be a significant aspect of classroom teaching. One of the most useful aspects of this research has been the identification of specific strategies which are more likely to help in developing a critical thinking disposition in students. These strategies can be used with any subject-specific content and therefore can be incorporated within my daily planning as a classroom teacher.

Two specific areas for future research emerged for me as I went through the research process. Firstly, I was very intrigued by the research that showed a connection between a critical thinking disposition and a decrease in mental health. Many high-achieving students struggle with high levels of stress, depression and anxiety and therefore considerably more research needs to be done in this area to verify this connection, along with the strategies for counteracting the negative aspects of a critical thinking disposition on mental health. (Suldo et al., 2008)

Secondly, there was a dearth of research into how a classroom teacher can assess a critical thinking disposition. Most studies quoted included one of the commonly used, commercially available Critical Thinking Disposition assessments, or a researcher-developed questionnaire using portions of one of these assessments. As a classroom teacher in a public school, the funds for this type of assessment are not available, nor are they justifiable at this time due to a lack of outcomes regarding a critical thinking disposition in our local curriculum. The

development of simple, easily administered critical thinking disposition assessments for classroom teachers in order to inform their own practice would be incredibly useful.

Impact of Research on the Author

This research has significance for me in my teaching situation as the numerous benefits of a critical thinking disposition can be given as a rationale for the use of strategies and teaching techniques to further these dispositions. Despite the lack of CTD outcomes included in my curriculum, the evidence supports incorporating these strategies in my classroom. Students, in particular, but also their parents have been conditioned to see the attainment of a "good grade" as the primary purpose for all activities in school and is sometimes used as a reason not to participate fully in activities which are solely assessed formatively. Connecting the tasks in the classroom with the development of a disposition to help a student be more successful in other academic courses as well as their future career can be a motivating factor for students. This research has also given me specific strategies to use in my classroom, especially the use of concept-mapping and ill-conceived problem-solving tasks, which I intend to use more frequently and will incorporate into my regular practice. Finally, although I have been convinced of the importance of teaching for the development of a critical thinking disposition in my classroom, I have many students who struggle with anxiety and depression. I appreciate the awareness this research has brought me about a possible link between the two.

A critical thinking disposition benefits both individuals and society as a whole. Individual decisions are increasingly having a greater effect globally. The ability to make informed, well-reasoned decisions needs to be paired with the inclination and awareness of the need to do so. The United Nations has identified global climate change as the defining issue of our time, one

which will impact all aspects of life (United Nations, 2022). From water availability and food security to severe weather and public health, all individuals around the globe will be affected. A critical thinking disposition needs to be emphasized within both a democracy and an economy where individual decisions are critical to our future. A critical thinking disposition is not innately present in individuals and needs to be nurtured over many years through explicit instruction and dedicated focus within the classroom.

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APPENDICES

APPENDIX A

IMPORTANCE OF A CRITICAL THINKING DISPOSITION IN LITERATURE

Table 3: Summary of studies analyzed with respect to the importance of developing a critical thinking disposition.

Author	Title	Category of significance	Positive, Negative or No Effect	Totals
Ahn	Moral sensitivity and critical thinking disposition of nursing students in Korea	Occupational skills	-1	14
Cansoy	Examining the relationship between pre-service teachers' critical thinking disposition, problem-solving skills, and teacher self-efficacy	Occupational skills	2	
Chen	Relationship between critical thinking disposition and research competence among clinical nurses	Occupational skills	1	
Cruz	What critical thinking skills and dispositions do new graduates need for professional life? Views from Portuguese employers in different fields	Occupational skills	2	
Ekinci	A study on the relationships between teachers' critical thinking dispositions and their perceptions of occupational professionalism	Occupational skills	2	
Kim	Mediating role of critical thinking disposition in the relationship between perceived barriers to research use and evidence-based practice	Occupational skills	2	
Midilli	The relationship between critical thinking disposition and Problem Solving in Nurses	Occupational skills	1	
Paans	Determinants of the accuracy of nursing diagnoses - Influence of ready knowledge, knowledge sources, disposition toward CT and reasoning skills	Occupational skills	1	
Profetto-McGrath	Nurse educators' critical thinking dispositions and research utilization	Occupational skills	2	
Pu	Influence of critical thinking disposition on the learning efficiency of problem-based learning in undergraduate medical students	Occupational skills	2	
Bell	The impact of critical thinking disposition on learning using business simulation	Academic achievement	2	9

Author	Title	Category of significance	Positive, Negative or No Effect	Totals
Comer	Impact of students' strengths, critical thinking skills and disposition on academic success in the first year of a PharmD program	Academic achievement	2	
Guner	Linking critical thinking disposition, cognitive flexibility and achievement: Math anxiety's mediating role	Academic achievement	2	
Oh	Influence of perceived helicopter parenting, critical thinking disposition, cognitive ability and learning motivation on learning behaviour on nursing students	Academic achievement	1	
O'Hare	The validity of critical thinking tests in predicting degree performance	Academic achievement	1	
Redding	Critical thinking disposition as it relates to academic achievement in baccalaureate nursing education	Academic achievement	0	
Stupsnisky	The interrelation of first-year college students' critical thinking disposition, perceived academic control and academic achievement	Academic achievement	1	
Tafazzoli	The relationship between critical thinking dispositions and academic achievement in Iranian midwifery students	Academic achievement	0	
Kim	Nursing students critical thinking disposition according to academic level and satisfaction with nursing	Personal well-being (Career satisfaction)	1	
Liu	How do critical thinking ability and critical thinking disposition contribute to mental health of university students	Personal well-being (Mental health)	-2	-2
Redding	Critical thinking disposition as it relates to academic achievement in baccalaureate nursing education	Personal well-being (Resilience)	-1	
Sk	Effects of emotional intelligence and critical thinking disposition on resilience of the student in transition to higher education phase	Personal well-being (Resilience)	1	

Author	Title	Category of significance	Positive, Negative or No Effect	Totals
Sugiura	The dual effects of critical thinking disposition on worry	Personal well-being (Mental health)	-1	
MacPherson	Cognitive ability, thinking dispositions, and instructional set as predictors of critical thinking	Societal benefit (Avoiding misconceptions)	1	4
Mizokawa	The influence of foreign experience and critical thinking disposition on moral and legal consciousness	Societal benefit (Pro-social behaior)	2	
Nakagawa	Effect of critical thinking disposition on household earthquake preparedness	Societal benefit (Responsibility)	0	
West	Heuristics and biases as measures of critical thinking: associations with cognitive ability and thinking	Societal Benefit (Avoiding misconceptions)	1	

APPENDIX B

TECHNIQUES FOR NURTURING A CRITICAL THINKING DISPOSITION

Table 4: Summary of studies looking at different techniques for teaching a critical thinking disposition.

Author	Summary	Strategy	Impact
Abrami	Mix of direct-instruction in developing critical thinking skills and infusion of these skills with content has greatest improvement in critical thinking dispositions.	Focussed instruction on critical-thinking and infusion with content.	positive
Abrami	Dialogue (whole class discussions and small group discussions led by teacher) and authentic or anchored instruction (applied problem-solving and role-playing) had a more significat improvement in CTD than control groups	Dialogue and authentic instruction	positive
Albert	Correlation between bilinguialism and critical thinking disposition	Multiple-language opportunities	positive
Arsal	Use of microteaching situations resulted in statistically greater increases in critical thinking dispositions in pre-service teachers than those utilization traditional methods.	Microteaching (students teach short, controlled lessons)	positive
Arsal	No statistical difference between control group and those who participate in inquiry-based learning	Inquiry-based learning	neutral
Atay	Significant increase in critical thinking disposition in nursing students who were taught to use concept maps while developing care plans.	Concept mapping	positive

Author	Summary	Strategy	Impact
Ceylan	Significant increase in critical thinking disposition scores following five-day summer program. Greatest gains were in critical clarity and reflective skepticism.	Out of school learning experiences	positive
Chan	Participants who created and shared digital content saw increases in their critical thinking disposition and self-esteem and decreases in ethnocentric thinking	Digital content production	positive
Cheng	Classroom learning environment has a stronger effect on critical thinking disposition than critical thinking skills. In general a content-oriented environment has the most significant impact as well as including multiple perspectives and challenging task completion	Challenging task completion. Multiple perspective taking.	positive
Coskun	Positive relationship between both value of sensitivity and respect for diversity and critical thinking disposition.	Training in sensitivity and respect for diversity	positive
Dehghanzadeh	Flipped classroom saw a significant increase in critical thinking disposition while traditional teaching methods saw no increased.	Flipped-classroom techniques	positive
Du	Problem-Based Learning was positively correlated with critical thinking disposition but not academic performance	Problem-based learning	positive
Ernst	Significant increase in critical thinking disposition scores of 12th grade students taking environment-based courses. No effect in 9th grade students.	Environment-based programming	positive

Author	Summary	Strategy	Impact
Fung	Collaborative group work in conjunction with direct instruction guiding students in argumentation results in greater improvements in critical thinking disposition.	Argumentation-based teaching, collaborative group work	positive
Gunawan	Improvement in critical thinking disposition following the use of interactive multimedia problem-based activities	Problem-based learning, use of interactive multi-media	positive
Hisako	Cross-cultural studies and experiences help develop a critical thinking disposition	Cross-cultural experiences and studies	positive
Kaya	Positive correlation between emotional intelligence and critical thinking disposition, but long timeline often required	Emotional intelligence	positive
Khalil	Reflective practice training and implementation showed significant gains in critical thinking dispositions	Reflective practice	positive
Ko	No significant impact in critical thinking disposition compared to control group after multi-mode simulation, but improvements in critical thinking skills.	Use of computer simulations	neutral

Author	Summary	Strategy	Impact
Laird	Involvement in diversity courses was correlated with increases in critical thinking dispositions. Amount of interaction of students with diverse peers was correlated with increases on the Open-Mindedness scale.	Interactions amongst diverse peers	positive
Lampert	Arts majors showed greater gains in some aspects of CTD development than non-arts majors. Specifically truth-seeking, open-mindedness, and maturity. Suggested that non-art programs become more accepting of divergent thinking and less authoritative.	Heuristics and critique-like discussions	positive
Leader	Ill-structured problem-solving can help strengthen critical thinking disposition, particularly attitude-strengthening aspects	Ill-structured problem-solving activities	positive
Maquivar	Motivation to attend class was higher in active learning class than traditional learning environment. No significant impact on critical thinking dispositions.	Active learning	neutral
Mathews	Student perception of their ability to exercise control in the learning environment. Combine strategies within content domain.	Classroom environment where students play a role in decision-making.	positive
Meral	Positive correlation between students' argumentation skills and critical thinking disposition.	Argumentation-based teaching	positive

Author	Summary	Strategy	Impact
Mirzaie	Improved quality teaching methods saw most significant improvement in critical thinking disposition measures.	Strong teaching methodology	positive
Nasution	Statistically significant improvement in critical thinking development after using a combination of case study and concept map interventions.	Combination of concept-mapping and case studies	positive
Noone	No effect of mindfulness meditation on critical thinking skills or dispositions	Mindfulness	neutral
Noone	No difference between critical thinking disposition skills based on mindfulness practices.	Mindfulness	neutral
Ozturk	Students in problem-based learning program saw greater improvements in critical thinking disposition than those in traditional program. Gains were greatest in truth-seeking and open-mindedness.	Problem-based learning activities	positive
Seife	Computer games had a positive impact on academic achievement but no effect on critical thinking disposition.	Computer games	neutral

Author	Summary	Strategy	Impact
Song	No difference in critical thinking disposition between hands-on simulation and video-review of simulation.	Use of hands on simulations	neutral
Sulaima	Weak positive correlation between harmonious passion and critical thinking disposition.	Encouraging students to find their passion	positive
Wohlers	No difference between having students in small, collaborative groups with one instructor and 1:1 ratio between instructor and student	Small group collaboration	neutral
Wu	Significant gains were found in open-mindedness, inquisiteveness, cognitive maturity, and systematicity following intervention using mind mapping.	Mind mapping	positive
Yang	Intentional teaching of critical thinking skills in students with low critical thinking skills saw an improvement in critical thinking disposition as well. Online discussions, both synchronous and asynchronous, improved critical thinking dispositions.	Instruction in critical thinking skills	positive
Yu	Problem-Based Learning was positively correlated with critical thinking disposition.	Problem-based learning	positive

Author	Summary	Strategy	Impact
Zhang	Having students participate in blended (online and in-person) learning activities saw greater improvements in student perceptions of their critical thinking dispositions than those who were in-person only. Students participate in online discussions, increasing expression of differing perspectives	Online discussion and group work to encourage expression of multiple perspectives.	positive