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Thought Forge: Investment in Critical Thinking

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Abstract

Critical thinking is an essential part of holistic education. Research shows that it has benefits across curriculum. In both core subject areas and elective subjects alike, critical thinking benefits the development of the needed thought processes. Despite this it is woefully underrepresented in classroom. Thought Forge is a program designed to provide accessible and fun critical thinking curriculum through technology. Designed as a longitudinal difficulty scaffolding program, Thought Forge aims to assess, develop, and reveal critical thinking skills in students of all ages.

Keyterms: Critical thinking, education technology,

Preface

For the past 8 years I have worked almost exclusively with children in an educational setting. I began in college advising first year students. There I worked with them to discover their passions; I advised them on adapting to college life, and I counseled them on the choices that they made. In that position I saw incredibly talent and intelligence flourish or fail, often based on the ability to make one decision. After working in that environment for 3 years I shifted my focus to middle school. In a small border community with little to no diversity I worked to teach US history to groups of 8th graders who were entirely unprepared to explore abstract concepts like morality, sovereignty, and the US government.

After two years, and more failure than success, I again changed my view. This time I worked in elementary afterschool programs. This gave me the opportunity to see and incredible period of growth where children shift into being students and students for the first time truly explore their understanding of the world. It also gave me the opportunity to see where students are being stifled at incredibly young ages as well as the resilience they have in growing none the less.

Finally I returned to middle school and saw how the insights I'd gained elementary reflected themselves in older children. Back in middle school I saw that the resilience I'd seen in elementary had turned to callousness in these children. Years of standardized testing and inadequate preparation had taught many of them the in their own word, "No matter how hard I try, it won't be enough." In distilling experiences with hundreds of children across the country I have attempted to understand what is the blind spot in education. I will not claim to have

entirely succeeded but I believe that a renewed push for critical thinking in education is an essential step forward towards creating effective preparative education.

Creating Thought Forge

Thought Forge is a curriculum with the primary task of assessing and improving critical thinking skills. Much of the field of assessment and improvement in critical thinking today is focused around higher education. In addition the methods by which it is assessed is often pidgin holed into the same standardized categories. These standardized assessments may take the form of essays or multiple choice, or even in person interviews, but they all suffer from key problems. First, time is a key component to the development of critical thinking (Ennis, 1993). In focusing on higher education and even high school, curriculum misses important stretches of time and development. The traditional pre-test, instruction, post test method is too short term and may not adequately adapt to developmental factors. This problem extends itself to the next key issue, the designs themselves.

If we hope to expand critical thinking testing into younger ages in a meaningful way, there needs to be shift in how the curriculum is presented. Multiple choice tests are flawed inherently(Ennis, 1993). One bad day, a missing bubble, or a miss read question can completely ruin an attempt at the test. Interviews measure only the aspects the interviewer finds applicable and the social human aspects, while valuable and essential may taint the evaluation. Essays measure writing skill, whereas critical thinking is a highly decision and evaluation based discipline. The problem with all these methods is not only that a given student may not be good at them, but that even if a student has skill in them they are limited to displaying only that skill. Thus there needs to be a more holistic based approach to critical thinking assessment.

To make things clear by holistic I do not mean a test, then an essay, then and interview. As a millennial myself I find the thought of such a thing mind numbing. In order to benefit children this curriculum must entertain and motivate. In the paper "Critical thinking: Its relevance for education in a shifting society" Leandro da Silva Almeida and Amanda Helena Rodrigues Franco write (da Silva Almeida & Helena Rodrigues Franco, 2011),

> "Authors suggest that, more than the potential itself, the decisive element here is truly a proactive and motivated attitude. If the motivational component—which cultivate the application of theoretical and practical components—is absent, a strong knowledge about critical thinking skills and the mastery in their use will prove to be insufficient (Facione, 2010; Halpern, 1999). Critical thinking entails the translation of cognitive skills into behavior (Saiz & Rivas, 2010; Sternberg, 1997), which will not happen if deprived of motivation (Facione, 2010)."

My own experience tells me that this effect would only be multiplied in relation to children.

Thus far, our new construct for critical thinking assessment must: be longitudinal, holistic, and motivational. Addressing the time frame first, Thought Forge will be an open ended curriculum. This means it will continue for as long as the user or teacher desires to use it. In terms of being holistic, thought forge will take the form of a long term situational simulation. This will allow the implementation of different measure including but not limited to: Decision making, knowledge application, logic assessment, argument assessment, creative problem solving, and myriad others. Lastly in order to motivate children, Thought Forge functions as a game. The Kids & Gaming report by the NPD group says that in 2013 91 percent of children ages 2-17 participate in some form of gaming (The NPD Group, Inc., 2018). By utilizing this

already standing massive buy in Thought Forge can cause real change through motivational and engaging activity.

A Gap in Essential Learning

Critical thinking is an essential portion of a full, complete, and preparatory education. It transcends traditional school subject models and instead functions as a kind of interdisciplinary supplement benefiting any and all subjects. In math critical thinking helps to create the necessary path ways of understanding needed to build understanding (Kastberg, 2003). In Science it fosters the curiosity and exploration that pushes innovation. In Social Studies it creates the analytic skills necessary to understand and apply complex understandings of complex situations. In Language arts it is the key to utilizing and playing with language in the efficient, creative, amusing, and powerful ways. Finally in life, critical thinking should be the foundation of our decision making.

Despite the essential nature of something as simple and powerful as trained thought, in most educational settings critical thinking is not explicitly taught or explicitly valued. Instead it is assumed it will come as a side product of other subjects. Somehow magically understanding the proofs of math or the derivations of science will apply to figuring out whether a used car dealer is trustworthy or which news source is worth attention. This a posteriori approach to an a priori essentiality leaves a huge blind spot in the affected populations, namely the current, previous and future generations. There is an increasing tendency within public and private education to marginalize the teaching and practice of critical thought. This process can be seen in the systematic defunding of both the Social Studies and Language Arts fields, as well as a

complete absence of philosophy in schools. This trickles down more and more often into other areas of life for growing children.

In the past philosophy was taught in schools preparing students for critical thought at a young age. Now student are lucky to get one social studies class a week. Between elementary and middle school this is likely only history. Only upon reaching secondary and post secondary education are our children exposed to a greater body of study in regards to thought.

We are left with generations of forced late bloomers who haven't been given the chance to learn. This is already coming back to bites us. The generation most recently to come through schools has very little to no foundation in social studies or critical thinking. As I explore within schools I am more and more cognizant of the inability of students to answer simple social studies questions. More so they are unable to take basic critical positions around an issue. If this problem is not addressed we greatly risk the competency of our progeny. Social studies informs us on how we view the world. It develops the interactive abilities and frames the world around us. Critical thinking is personal processing power. It can be applied to any and all subjects and supports students throughout life. Without these key competencies our students will be poorly equipped to survive and thrive in the world to come.

Exploration of Critical thinking and Literature review

Discussions on Critical thinking

Before attempting to measure and teach critical thinking, the concept must be accurately defined. This in itself poses a problem. In a brief review of the literature, I came across over 12 definitions of critical thinking. Included in those was the idea that critical thinking changes as the discipline changes i.e. the critical thinking needed for science is not the same as that needed for

foreign language. With this idea in mind the Thought Forge definition of critical thinking must be broad enough to be useful across disciplines while being narrow enough to be achievable.

One important touchstone in the understanding of education and in particular the teaching of critical thinking is Bloom's Taxonomy. Named after Benjamin Bloom, Blooms taxonomy is a set of six competencies that educations strive to develop within students(Kastberg, 2003). These domains include:

Knowledge: the capacity to recall specific information about a given subject.

Comprehension: the capacity to understand the conclusion that comes of a given set of premises

Application: the capacity to use information in the process of solving problems

Analysis: the capacity to "Break down informational materials into their component parts so that the hierarchy of ideas is clear(Kastberg, 2003)."

Synthesis: the capacity to create new informational ideas from disparate information.

Evaluation: the capacity to assess the value of information accurately.

These capacities provide a valuable basis on which to judge the capability of critical thinking curriculum.

Robert H. Ennis's work serves to synthesis these capacities and first describes critical thinking as, "reasonable reflective thinking focused on deciding what to believe or do**.**" Ennis continues to dissect this definition and determines it to be the surface level the deeper skill needed to define the practice. He expands the definition into ten skills one must execute in order to practice "reflective thinking focused on deciding what to believe or do (Ennis, 1993)**."** For Ennis these skills are cross-curricular and can be applied to all subjects**.** These skills include the ability to

1. Judge the credibility of sources.

2. Identify conclusions, reasons, and assumptions.

3. Judge the quality of an argument, including the acceptability of its reasons, assumptions, and evidence.

4. Develop and defend a position on an issue.

5. Ask appropriate clarifying questions.

6. Plan experiments and judge experimental designs.

7. Define terms in a way appropriate for the context.

8. Be open-minded.

9. Try to be well informed.

10. Draw conclusions when warranted, but with caution (Ennis, 1993)**.**

Robert H. Ennis, goes on to take a systematic look at common methods of assessing critical thinking and their efficacy. Ennis asserts that there are 7 essential reasons for which we must test critical thinking (Ennis, 1993). Those domains are:

1. Diagnosing the levels of students' critical thinking.

2. Giving students feedback about their critical thinking prowess.

3. Motivating students to be better at critical thinking.

4. Informing teachers about the success of their efforts to teach students to think critically.

5. Doing research about critical thinking instructional questions and issues.

6. Providing help in deciding whether a student should enter an educational program

7. Providing information for holding schools accountable for the critical thinking prowess of their students.

Ennis's work can be used as a tool to draw the clinical and research oriented Bloom's Taxonomy, into the more practical and student centered classroom. His essential reasons provide the "why" of the necessity of critical thinking in the classroom. He attempts to create a more precise conception of how critical thinking can be used assessed and taught. This depiction while useful is not without its possible flaws.

These possible flaws are outlined in by John McPeck in "Critical Thinking and Subject Specificity: A Reply to Ennis." In this article McPeck asserts not that critical thinking skills are not useless but are subject specific. McPeck views the forced generalization of these skills as taking away the usefulness of the skills themselves. His view is that each subject matter has specific thinking skills that bolster the understandings involved therein. The best conception presented in the article is that if have significant skill in the field of logic and critical thinking, that would not make me qualified to apply such skills in other fields (McPeck, 1990).

McPeck raises an essential point. Can we apply critical thinking teaching across subject matter? If we can't then there is much less reason to hold it as an essential part of the classroom. Instead it should be folded into subject curriculum.

Stephen Norris tackles this essential question and in particular responds to McPeck. Norris frames this article around two essential inquiries of his own. The first is the same as McPeck, i.e. can critical thinking skills be generalized cross-discipline? The second is how critical thinking skills can be assessed. (Norris, 1988).

To begin with Norris expands Ennis's conception of critical thinking by likening it to inferences. Norris sees critical thinking as ones "inferential ability." He goes on to assert that this inferential ability or "conclusions based on beliefs or actions" have applicability across subjects. According to Norris, the use of inferential ability in the evaluation of hypotheses can be used to

validate and make decisions in many different subjects.   This line of though seems to have

merit. Moving back to address Mcpeck's ideas around direct application (I have critical thinking

skill but I wouldn't apply it to physics) there is an essential flaw in this conception. This flaw can

be demonstrated by a simple thought experiment. Let's say there are 2 candidates for a position

in a physics based profession. Both candidates have absolutely no experience in physics. If one

candidate has extensive training in critical thinking and problem solving which candidate would

be more likely to be chosen. Critical thinking very obviously adds something to the study of any

subject. While it may not be directly applicable to the information in a given subject, the thought

processes involved are useful even if just as something to be built upon.

Application of Critical thinking

In a perusal of the literature one can find articles on critical thinking spanning numerous

subjects. There is the some what obvious Social Sciences and Language Arts, but expanding

from there are articles on Critical thinking in Art, Music, Nursing, and mathematics. Across the

articles the authors make their disciplines connection to critical thought.

In their article "Critical Thinking and Artistic Creation" David A. White and Robin

Robinson outline 4 steps to an effective model of critical thinking. In particular White and

Robison created this model in order to outline the use of critical thinking in art and the

humanities, but note that it can also be used inter-disciplinarily (Robinson, 2001). It takes a step

forward from Ennis's model towards an applicable process that can be used in the classroom.

Clear steps are put forth, making it more accessible to students.

The first step set forth by White and Robinson is to *State the problem.* They explain that

students need a clear goal in order to move towards solutions. A core competency in critical

thinking is being able to clearly and explicitly state the problem being faced. In many years of

working with children I have experienced that a key skill that needs to be trained is the ability to

recognize what exactly it is that is being asked of them. In primary grades this can often be

simply identified i.e. *What kind of answer is this math problem looking for* or *What year did this*

event happen. As children advance in schooling however, the problems asked of them become

more and more complex and abstract. Solutions contain multiple steps or within the solutions

themselves contain multiple degrees of correctness. Without adequate training or experience in

examining and dissecting these abstractions students can be left without the ability to move

forward in their thought (Robinson, 2001).

The second step set forth by White and Robison is to *formulate a Hypothesis to solve the*

problem. After effectively describing the problem this step encourages students to examine their

own experiences and isolate those that have a particular pertinence to the problem. These

experiences are then to be used as references and tools in order to inform them in the next

step(Robinson, 2001).

The Third step of this model is to *Infer a Conclusion from this Hypothesis*.   Here, using

the informative experiences cataloged in the previous step, the student creates a hypothesis to

solve the problem (Robinson, 2001).

The fourth and final step of this process is to *Evaluate the strength of this Conclusion.*

This step requires students to examine the value their drawn conclusion. The value can be found

through comparison with the context surrounding the decision and how well it stacks up against

other possible conclusions (Robinson, 2001).

Interestingly Robinson and White draw this frame work for connection to critical

thinking in the art class room. Specifically they connect it to theater and the analysis and

understanding of one's character though dialogue.

While this framework provides a good basis from which to build, it excludes several key aspects if critical thinking is to truly be used across the curricula. Foremost is its framing of critical thinking as the solution to a problem. While this is one domain in which critical thought is beneficial it is too narrow to be the container for the entire practice. Several genera of critical thinking are seemingly unexplored by this model, namely generative practices. This could include things such as generating opinions, creating narratives, and brainstorming new ideas. One could argue that if the problem described is given a broad enough scope i.e., "The problem is that I need to write a story" or "the problem is that I need an opinion on this subject," that they would still be included in the White-Robinson model, however it still seems to lack the substance of the process involved when one is writing or brainstorming.

Program Design

Thought Forge is a game, now what does that mean? The curriculum will be computer based and take students through virtual situations in which they will have to apply critical thinking skills. The theme of these situations will be tailored to the interest of the student involved. Themes could include mysteries, Sci-Fi, Fantasy, and Adventure. If there is a genre a Thought Forge scenario could be created for it. In addition to the situation provided in the curriculum educators, parents, and students themselves would be provided with the tools and knowledge to create their own scenarios and share them through the platform. Whichever scenario is picked the process would then fall into the familiar and flawed rhythm of pretest, instruction, post test. The difference would come in the time frame and shape this rhythm takes. Every decision and action in Thought Forge would be data towards assessment of the student's skill. Meanwhile the consequences of those actions would be instruction towards around the decision made. The situations presented would then be scaffoded to the level of skill

demonstrated. These situations would be designed to measure several important constructs

involved in critical thinking. (see appendix A)

The constructs developed to this point as well as those to come are draw from blooms

taxonomy of education and are designed to function measure over all ability to function at an

evaluative level. In the initial stages of a student using the Thought forge platform these would

be separate measurement, but the student learns and develops these differing concepts would be

integrated within the problems the students face.

Starting at the most basic level of Internal-Decision, students would be faced with a

simple scenario:

You are on a path in the forest. You are late for your destination. You come to a fork in the path.

One way leads to a shortcut. You have never traveled this shortcut but it would allow you to get

to you destination on time. The other direction leads to your destination, but is longer and you

will definitely be late. Which path do you choose?
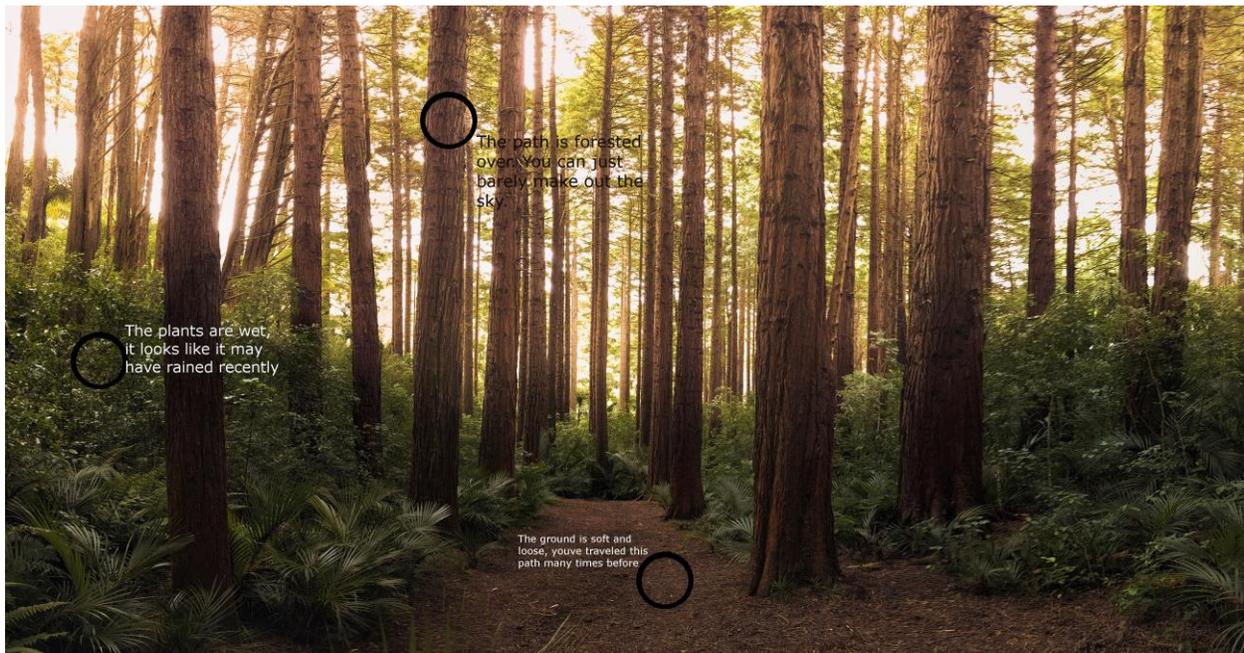
As students mouse over different areas in the picture, pop ups give additional information about

the decision. This pattern continues recording the students decisions until they reach the final

conclusion. In future attempts at the Internal Decision module, students will be given different

choices. As their experience grows, they will be given access to additional modules as well as

different information.

Challenges in Moving Forward

There are many issues facing the development of Thought Forge. First and foremost is

the concept of critical thinking.   As mentioned before the definition of critical thinking is

debatable and even defining it as one unified concept could be questioned. This could create a

problem as an important portion of the development of the curriculum is the definition.

Another potential problem comes in the form of time. It will be incredibly hard to gather

data on the effectiveness of the curriculum as the development of critical thinking is not a quick

endeavor. It will take extended and extensive use in order to discover what exactly works and what doesn't work.

Beyond the actual creation of the product, finding its position in the market could be a challenge in itself. Educational technology floods the market and gives schools myriad choices from which to choose. Programs like Everfi, Matific, Education City, and numerous others work towards accomplishing similar goals, with more money, foundation, and resources.   Breaking into the educational technology space without the financial or technological support that these competitors have poses a significant challenge.

Another consequence of the full market is the pressure teachers have had to adopt these program. In my own experience teaching I have felt the pressure school and districts put on teachers to incorporate technology into their classrooms. At the same time I have seen the push back many have towards the large changes that can be involved programs like thought forge and others.

In According to the 2015–16 National Teacher and Principal Survey administered by the US Department of Education, the average age of teachers in the was in the mid 40s while the average teacher had been teaching for over 10 years(Taie, Goldring, & Spiegelman, 2017). We have a population of teachers with over a decade of experience. The process of adoption for technology for these teachers can be difficult. In 2009 only 40 percent of teachers reported frequent use of technology in the classroom. As a new program Thought Forge will only have a greater difficulty.

Leadership methodology

Critical thinking is and underpinning of many leadership philosophies. Most notably is Heifetz's concepts of adaptive and technical issues. Technical issues are issues that have a

known solution. They are issues that while not necessarily easily fixed, have some kind of established why to work towards a resolution (Heifetz & Linsky, 2002). Examples include: reducing the speed limit to curb accidents, or giving incentives to raise school attendance. These are solutions that may show lasting results, but require no new learning on the part of the participants. They fail to change the belief mechanism involved in motivating the participant. While the technical issue may be low attendance numbers or too many accidents, the adaptive challenge is the mental models in place that inform children and parents that schooling is not essential. Adaptive problems and their solutions go beyond that surface level to the root causes of issues. Often there are many technical issues associated with one or more adaptive challenges. Adaptive challenges are the disease where as the technical issues are the symptoms (Heifetz & Linsky, 2002).

Technical issues are abundant in the world, and after a review of Heifetz 2002, we are often tempted to eschew them as unimportant in favor of focusing solely on the adaptive. The truth however is that the adaptive is mired in the technical and in order to treat the disease we must thoroughly understand the symptoms. Critical thinking can be an elixir towards both, but our education system just barely prepares children to function and identify issues at the surface-technical level. As children grow and are infrequently or never exposed to thought on adaptive challenges they lose essential time to start building their capacity to do so. Consequentially when they are faced with such issues without adequate preparation or training they instead reduce it back to the familiar technical. The cycle continues raising a generation of adults loathed to look beyond the symptoms.

In the current era of flux and change we are exposed and drawn to the charismatic leaders, those leaders whose presence and gravitas draw us towards their causes instinctually.

We yearn for them to be transformational and their messages seem to be so. However the issues they purport to solve are adaptive and sometimes the solutions they provide are technical. If we have a population that has been trained to avoid the anxiety that comes with adaptive issues we validate and elevate those charismatic leaders that promise us the technical solutions to adaptive problems.

My personal conception of leadership hinges on this consequence of critical thinking, wisdom. Wisdom is the ability to use knowledge, experience, and resources to make beneficial decisions. Wise leadership entails the acknowledgement of what a leader and their followers bring to the table and the leveraging of those advantages. Wise leadership is the drive and ability to question the context around you for the benefit of those you lead. Wise leadership is the accumulation and acknowledgement of broad interpersonal experience and the application of that experience to your ideas and choices. If leadership is a journey, thought is your sense of direction. You may get lost regardless, but if your thought is skillful and honed, then you will find your way back.

Appendix A

Situation Style	Presentation	Measurement	Support
Internal-Decision	Student would be place in a situation designed to force them to make educated decisions towards the outcome.	Designed to measure skill at making and evaluating self made decisions and their consequences	Detailed information around the aspects of each possible choice. As the exercise is scaffoded up, the student would be expected to discover the information themselves or infer the information from previous knowledge.
External-Decision	Students would be placed in a situation where they are forced to evaluate the decisions made by others.	Designed to measure skill at making and evaluating decisions made by others and their consequences.	Detailed information around the person making decisions and the situation itself.
Problem solving	Students are tasked with solving problems of increasing complexity and difficulty	Designed to measure and improve the ability of students to work through complex problems	Repeatability, possible solutions.
Justification	After taking an actions students would be tasked with justifying the logic behind that action.	Designed to measure and improve the ability of student to justify actions that they have taken and to evaluate those justifications.	Record of previous actions. Displayed consequences. Integration with decision making module.
Analysis	Student would be given information and a problem and tasked with finding the pertinent information	Designed to measure and improve the ability of the student to find and utilize information.	

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