Exploration of Cultivating Critical Thinking through the Extended Essay: Strategies for High School IB Students in the Age of Generative AI

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Abstract: *The widespread application and rapid development of Generative Artificial Intelligence(AI) are reshaping teenagers' paradigms of knowledge acquisition and their cognitive environments. High school students are confronted with multiple challenges including the verification of information authenticity, ethical judgment, and original thinking. The Extended Essay (EE), a core component of the International Baccalaureate Diploma Programme (IBDP), offers a systematic inquiry-based educational approach to cultivate students' critical thinking and research literacy. This paper investigates how EE promotes the development of critical thinking among IB learners and identifies the obstacles faced by IB schools, teachers, and students during the EE implementation and proposes targeted strategies for improvement. This research provides both theoretical insights and practical guidance for cultivating high school students' critical thinking through EE and adapting IBDP education to the demands of an AI-mediated educational landscape.*

Keywords: *Critical Thinking, Extended Essay, International Baccalaureate Diploma Programme, Generative AI, Educational Strategies, Academic Integrity*

1. Introduction

The accelerated development of artificial intelligence (AI), spearheaded by the dissemination of Generative AI tools such as ChatGPT, Claude, and DeepSeek, has greatly impacted the modality of learning and cognitive environments of adolescents. A nationally representative survey conducted by the Pew Research Center in 2024 found 26% of teens aged 13 to 17 in the United States having used ChatGPT to do schoolwork, a figure which has doubled since the 13% registered in 2023 [1]. Some experts warn that too much reliance on AI may reduce the thinking process to oversimplification and weaken the intrinsic motivation of learners to think for themselves [2]. Apart from this, large AI models are capable of producing coherent and organized text in a short time, but the "knowledge" it outputs tends to lack profound judgment, moral consideration, contextual awareness, and originality [3]. Against this backdrop, developing the abilities of learners to detect misinformation, challenge authority narratives, participate in reasoning based on facts, and form independent opinions becomes a vital component of high school education.

The International Baccalaureate Organization (IBO) has incorporated the Extended Essay (EE) as part of the International Baccalaureate Diploma Programme (IBDP) essential elements, with the aim of promoting higher-order thinking skills through the academic composition. The EE requires students to carry out an independent research project leading to a 4,000-word paper in a selected subject field. Critical thinking, captured by the Paul-Elder framework, requires the systematic analysis of information through the lens of clarity, accuracy, and logical consistency [4]. In the context of the EE, this translates to the capability to develop meaningful questions, create evidence-supported arguments, and reflect on the process of their learning. This comprehensive process shifts learners from academic reading to knowledge expression, promoting the pursuit of academic integrity and systematizing the critical thinking skills, an essential trait in the IB learner profile.

This article aims to articulate how the various EE phases enhance the cultivation of the critical thinking and research capabilities of IBDP students, analyze some common challenges faced with implementation and provide practical recommendations to enhance assistance and support to IB schools, teachers and students, while offering actionable strategies and insights to align educational practices with the imperatives of the AI era.

2. EE's Mechanisms for Cultivating Critical Thinking

Critical thinking has globally been accepted as a key component of quality education and a prerequisite for tackling the complex challenges of the digital age. Within the IBDP, the EE specifically aims at developing these skills. Wray has documented that IB graduates in the UK valued the research conducted in the EE and referred to the primary skill they developed through the exercise as being critical thinking [5].

2.1 Formulation of a Research Question

The EE embodies an inquiry-based learning approach. Students must begin by identifying a clear, focused, and arguable research question or hypothesis to investigate. This involves initial forays into a subject area, curiosity, and a capacity for recognizing a question as research-worthy. A good research question involves critical thinking from the beginning, as students need to examine gaps in existing knowledge and how they will contribute insights. It also fits Bloom's taxonomy, at the levels of "analyze" and "evaluate", by requiring precision and methodological adequacy in research question design [6].

2.2 Data Collection and Source Evaluation

Having framed the question, the students need to conduct independent research under the guidance of their supervisors. This involves gathering information from a range of sources (books, academic publications, experiments, interviews, etc.) as well as evaluating the credibility and relevance of those sources. Students learn to distinguish between reasonable evidence and assertions, to detect bias or limitations in materials, and to comment on findings in relation to different sources. These are classic exercises in critical thinking, requiring the analysis in breaking down information, examining arguments and weighing evidence.

2.3 Structured Argumentation and Reasoning

The EE demands a step-by-step, argumentative process from question generation through conclusion. Students are challenged to develop a logical argument, formulate hypotheses, present evidence, defend their rationale, refute counterarguments, and draw conclusions. Throughout, they are requested to move beyond the simple description of fact and undertake interpretation and critique of the topic. This rigorous process puts the student's critical cognitive paths in action, conditioning students to buttress claims with evidence and to adhere to the conventions.

2.4 Reflections on Planning and Progress Form (RPPF)

A unique aspect of the EE process is the focus on reflection. Students are required to record their planning and progress in three mandatory reflection sessions in a formal RPPF [7]. Through these reflections, the student reflects on what has been effective in terms of strategy, on how their thinking about the question has developed, and on what has been challenging or surprising in their research. Through reflecting, they learn to critically self-review their approach and the process is directly marked in Criterion E (Engagement) of the EE. This approach is further consistent with Dewey's theory of reflective thinking, in which he held that learning results from the interaction between experience and conscientious reflection [8]. It is in the process of reflectivity that the learners become conscious of their thinking strategies and deductive errors, thus improving their metacognitive ability.

2.5 Assessment Criteria

The IB evaluates the EE according to five criteria, with Criterion C: Critical Thinking (12 out of 34 points) being the most heavily-weighted criterion in the evaluation [7]. This criterion evaluates the extent to which the students use the research to build a reasoned argument, to what extent they analyze and discuss the results insightfully, and how thoroughly they assess strengths and weaknesses of the investigation. The weighting of this criterion reflects the IB's expectation that an outstanding EE is not only an information report, but an analysis demonstrating intellectual initiative and depth. The EE's assessment criteria further support critical thinking development through explicit evaluation of argument coherence, research design, and knowledge engagement. These criteria also create a self-reinforcing loop which integrates the intellectual standards embedded in theoretical models.

2.6 Alignment with IB Core Values

Both the IBDP EE and TOK focus on the construction of knowledge and its limitations and diversity. When students apply TOK concepts such as bias, causal fallacy, and the limits of knowledge in their EE research, they form a deeper "cognitive ecosystem", transitioning critical thinking from theoretical cognition to real-world application.

This approach is consistent with the IB's educational philosophy. The IB curriculum is student-centered and inquiry-oriented, aiming to "develop students who are thinkers and inquirers". According to the IB Learner Profile, IB students are expected to use critical and creative thinking skills to analyze and take responsible action on complex problems and to exercise initiative in making reasoned, ethical decisions [7]. In other words, fostering critical thinkers is at the heart of the IB's mission. Indeed, a study using a matched sample found that IB Diploma students scored significantly higher on a critical thinking assessment than non-IB students with a moderate effect size (d ≈ 0.5) [5].

3. Challenges in Cultivating Critical Thinking through the EE

Although the EE is a powerful vehicle for cultivating critical thinkers, its implementation in the actual educational environment is not without barriers. Not every student, teacher, or IB school considers the process of the EE to be equally simple, and the emergence of AI tools in education has introduced increased intricacy.

3.1 Student-Level Challenges: Limited Research Literacy

3.1.1 Difficulties in Formulating Research Questions and Evaluating Sources

Many IB students struggle with selecting appropriate research topics as well as evaluating critically the information sources. The IB acknowledges that about 35% of graduates found developing a good research question to be "too challenging," emphasizing the importance of sustained support in this area [9]. Additionally, high school IB learners often face difficulties in assessing the academic value of information, leading to superficial arguments and an over-reliance on non-academic sources.

3.1.2 Inadequate Academic Writing and Logical Structuring Skills

IBDP students come from diverse educational backgrounds and have varying levels of research experience when they begin the EE. Some students may lack foundational skills in academic writing, source analysis, or time management, which can make the EE process overwhelming. Moreover, many IBDP students frequently lack the skills required for coherent academic writing and logical argumentation. This deficiency manifests in disorganized essays with weak evidence support, undermining the demonstration of critical thinking.

3.2 Teacher-Level Challenges: Variability in Supervisory Expertise

3.2.1 Insufficient Targeted Professional Development and Critical Thinking Guidance

Developing students' critical thinking through the EE also depends on teachers' pedagogical knowledge and their beliefs in students' autonomy. Some educators may lack formal training in supervising research at the secondary level, and they might be uncertain about how much intervention is needed. Moreover, the effectiveness of EE supervision varies, with some teachers lacking the background to guide students in developing inquiry-based research questions. This gap often results in a focus on superficial aspects of the essay, such as formatting, rather than on nurturing deep analytical skills.

3.2.2 High Student-to-Teacher Ratios and Workload Constraints

In many IB schools, IBDP subject teachers are responsible for supervising a large number of EE students or have heavy teaching loads, limiting their capacity to provide individualized support and frequent feedback.

3.3 School-Level Challenges: Structural and Curricular Limitations

3.3.1 Marginalization of the EE in School Curricula and Resource Gaps

High-quality EE research at the high school level requires information resources (libraries, academic databases, etc.) and training in research methods. Not all IB schools have equal access to such resources. Some IB schools treat the EE as a peripheral component, with insufficient systematic curriculum integration, and adequate resource allocation, such as access to libraries and writing workshops. Students in schools with limited library facilities may find it difficult to find appropriate sources or data suitable for EE. This may lead to the essay being just a descriptive compilation of easily accessible Internet resources, rather than a critical investigation. In addition, in many IB schools, EE is usually regarded as an isolated project rather than an extension of specific subject learning. This view leads to a disconnect between EE and academic disciplines, reducing the depth and applicability of students' research.

3.3.2 Emphasis on Final Product over Process

The EE is assessed externally and contributes to the student's overall DP score (up to 3 bonus points in combination with TOK) [7]. This high-stakes aspect can introduce pressure that sometimes drives students to adopt a "superficial" approach, such as choosing a safe topic, following a formulaic structure, or focusing on what they think the examiner wants, rather than taking intellectual risks. If students are too exam-oriented, they might be less willing to venture into truly critical analysis. Consequently teachers might inadvertently encourage formulaic approaches if they over-emphasize the assessment rubrics without conveying the deeper purpose of the EE. Moreover, despite IB's inclusion of process-oriented assessments like the RPPF, some IB schools still prioritize the final essay's quality over the developmental journey, neglecting thinking skills' growth.

3.3.3 Risks to Academic Integrity in the Age of AI

Another pressing contemporary challenge is the easy availability of AI tools that students might use inappropriately. In the context of the EE, a student could attempt to let an AI model generate essay paragraphs or critique sources for them. If unchecked, this behavior would undermine the purpose of the EE, as the student would not be developing their own analytical skills. Educators have reported that concerns about AI-related plagiarism have increased sharply. A survey has shown that 70% of teachers agreed that student use of AI on assignments counts as plagiarism or cheating [10]. Students' inability to critically assess AI-generated content's logical flaws or factual inaccuracies further exacerbates this issue.

4. Strategies for Enhancing Critical Thinking Development in the EE

Given the multi-faceted barriers, therefore, there is a need to move the attention from simply identifying problems to actually building specific strategies for improving the EE's potential to develop critical thinking and academic skills.

4.1 Curriculum Design: Establishing a Structured Environment for Critical Thinking

4.1.1 Implementing a Comprehensive Academic Writing and Thinking Curriculum

It is crucial to prepare students for the EE by embedding research and thinking skills into the earlier parts of the curriculum. Schools should introduce mini research projects or inquiry-based assignments in the pre-IB years or the IB Middle Years Programme (MYP) so that students can practice formulating questions, evaluating sources, and presenting arguments on a smaller scale before the high-stakes EE. By front-loading skill development, educators can ensure that EE candidates are equipped to engage deeply rather than superficially. Also, during the EE timeline itself, structured support should be provided in the forms of academic writing courses, seminars or workshops in order to better guide DP learners.

4.1.2 Enhancing Interdisciplinary Integration

The IBDP core curricula must be strategically integrated in schools. For example, TOK supplies the philosophical basis, while EE provides the subject area for scholarly inquiry, and CAS develops problem sensitivity and thinking ability in real-world contexts. Furthermore, integrating subject teachers' involvement in the EE promotes correlation with Internal Assessments (IA) and subject

curriculum, adding depth to the scholarship and utility of student research. This integration is aimed at improving the academic depth and practical applicability of students' investigative work.

4.1.3 Optimizing Assessment Mechanisms and Resource Allocation

EE instruction and evaluation in IB schools must emphasize developmental processes over end results. Mandatory reflection sessions and periodic check-ins can enable supervisors to give timely feedback and confirm the validity of students' work. These discussions prompt the students to clarify and justify their ideas, promoting better critical thinking and maintaining academic honesty. These practices also play a crucial role in enabling the supervisor to ascertain that the work indeed represents the student's own thinking and efforts. Furthermore, an EE center of resources in IB schools can give both the students and educators continued support. This center can furnish the latest templates and sample essays, writing guides, pathways to research, reflective tools, and thinking skills exercises.

4.1.4 Reinforcing Academic Integrity and Ethical Education

With the widespread of AI tools, it is imperative to strengthen awareness of academic ethics. The IB's updated Academic Integrity Policy includes specific guidelines on AI usage, emphasizing that any AI-generated content must be appropriately cited and cannot be presented as the student's original work [11]. To enforce this policy, IB schools must go beyond just penalizing cheating, and involve educating students why original thinking and proper attribution matter. In practical terms, schools can host discussions on the ethical use of AI, perhaps examining case studies of appropriate and inappropriate use, educating students on proper citation practices, plagiarism avoidance, and the use of Turnitin, GPTZero, and other AI detection tools to better support the cultivation of an honest academic culture.

4.2 Teacher Support: Enhancing Supervisory Competence in Critical Thinking Facilitation

4.2.1 Strengthening Professional Development for IB Supervisors

Providing opportunities for teachers to engage in official IB supervisor training or school-based workshops is vital. These programs should concentrate on strategies for guiding research-based learning and fostering higher-order cognitive skills, with emphasis on critical feedback language, problem-based instructional methods, and assessing student cognitive development stages. When a supervisor truly understands how to coach inquiry (e.g., asking Socratic questions, prompting deeper analysis, and encouraging reflection), the student's critical thinking can flourish. Conversely, if a supervisor sees the EE as a student's solitary endeavor with no need for discussion, the student might miss out on important formative feedback.

4.2.2 Establishing Collaborative Supervisor Communities

Forming internal or regional EE supervisor networks can facilitate regular exchange of case studies and organization of problem-solving workshops. Such communities promote the dissemination of best practices, sharing exemplary work and critical thinking models, reducing the learning curve for novice supervisors, and contributing to the standardization of guidance quality across the community.

4.2.3 Optimizing Faculty Allocation and Promoting Interdisciplinary Supervision

In scenarios of high student-teacher ratios or limited teaching resources, exploring interdisciplinary supervision models can hold considerable practical value. For example, biology and chemistry teachers can co-supervise biochemical EE topics, thereby enriching the research through complementary disciplinary perspectives while alleviating the workloads on individual supervisors. Moreover, implementing a multi-tiered supervision framework, such as peer review systems and academic assistant roles, can further optimize resource allocation. Peer review, guided by assessment rubrics, not only alleviate the supervisors' workload in preliminary checks of argument structure but also cultivate students' analytical skills. Academic assistants, drawn from senior students, can take on tasks such as training in literature search techniques and reviewing formatting standards, thus enabling supervisors to concentrate on methodological and critical thinking cultivation. Nevertheless, to fundamentally solve the teacher shortage problem, investment at the school level is necessary, such as creating full-time EE supervision positions or purchasing external academic supervision services.

4.3 Student Development: Fostering Cognitive Awareness and Reflective Depth

4.3.1 Enhancing the Use of Researcher's Reflection Space (RRS) and Structured Reflection

Encouraging students to actively note down their thoughts and engage with the RRS throughout the

EE process allows for the documentation of inspirations, challenges, and breakthroughs, and creates a comprehensive research trajectory. Designing multiple rounds of detailed reflections on RPPF tasks, accompanied by structured guiding questions (e.g., "What cognitive challenges did I encounter at this stage?" "How has my research perspective evolved, and why?"), can also aid students in recognizing and recording shifts in their thinking patterns.

4.3.2 Integrating Peer Review Mechanisms to Stimulate Critical Dialogue

Implementing peer assessment and group discussions, as mentioned previously, may encourage students to critically evaluate others' work, which in turn enhances their own writing quality and cognitive depth. This cycle of external evaluation and self-assessment fosters a multidimensional understanding of issues and elevates metacognitive skills.

4.3.3 Utilizing AI Tools to Facilitate Critical Thinking Training

Proper deployment of AI tools, including question-generation webs like Smile Ask, can dynamically stimulate brainstorming and enrich inquiry. Educating students to evaluate the effectiveness and reasoning of AI answers, and transforming AI from a threat to a useful tool is an important part of modern education. Importantly, it is crucial to emphasize that students must know that the prerequisite for applying AI is adherence to academic integrity.

5. Conclusion

Overall, the IBDP EE cultivates students' metacognitive and critical thinking skills in a systematic academic process. However, the effective implementation of the EE is hindered by a number of factors, including the limited research literacy of the students, the absence of supervisor training or time constraints, and the curriculum and resources limitations in IB schools, among others. To overcome these challenges, the study proposes holistic recommendations in student learning, supervisor support, and institutional arrangements. Nonetheless, the research recognizes some limitations, among them the need to empirically test the proposed intervention strategies and the necessity for ascertaining the views of the IB teachers and learners. Future study could center on examining the long-term effects of the interventions and the role of the evolving relationship between the EE and the development of the critical thinking of the high school IBDP students. The EE's inquiry-based model offers a scalable framework for cultivating AI-resilient critical thinkers, in line with the international requirements of integrating cognitive rigor into digital education.This research is expected to provide actionable insights for educators and policymakers to better implement EE and coordinate educational practices with the demands of the AI-mediated educational landscape.

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