Scenarios as Means for Identifying, Developing, and Accessing Critical Thinking in Pre- and In-Service Teacher Education: A Preliminary Discussion on the Findings of an International Collaboration

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Abstract
Critical thinking is widely considered a vital aspect of education, necessary for comprehending concepts and solving problems. Compelling evidence from various studies indicates that even a significant number of university graduates lack the ability to think critically, despite its emphasis in education. Critical thinking involves a process of reasoning that is reasonable, reflective, and aimed at deciding what to believe, how to proceed, and what to do. This study presents findings from research conducted by an international team of researchers hailing from three distinct teacher training institutions situated in Mauritius and India. The primary objective of this study was to gauge the extent to which both pre-service and in-service trainees exhibited critical thinking capabilities when confronted with carefully crafted real-life scenarios. The study population included a representative sample of trainees (n = 130 for pre-test; n = 57 for post-test). The outcomes of the study found that critical thinking skills are lacking among pre-service and in-service trainees in both countries, mostly in the action phase, required for problem-solving, while limited critical thinking could be identified in the thinking and reflection phases. The findings also emphasised that critical thinking is a crucial skill that has the potential to benefit both trainees and students in solving complex real-life problems and that critical thinking should be incorporated into the curricula of educational institutions at all levels to develop a mindset in trainees who can think critically, solve problems, and make informed decisions, thereby contributing positively to teaching.

Keywords: Critical Thinking, Real-Life Scenarios, Thinking-Reflecting-Action

Introduction

Critical thinking is a well-established concept within education, consistently featured in various curricula as a fundamental skill essential for comprehending complex concepts and effectively tackling problem-solving tasks. Despite its longstanding presence, critical thinking often remains elusive in the teaching and learning processes, often being dismissed as abstract or superficial (Ramma, et al., 2023). It has even been criticised as mere rhetoric, dogmatism, or ethnocentrism by scholars like Vincent-Lancrin (2023) and Wagner, Baum, and Newbill (2014). It is important to clarify that the term 'critical' in critical thinking originates from the word 'criteria' and should not be conflated with 'criticism' (Kasser, 2019). The skill of critical thinking holds significance not only within academic pursuits and professional environments but also plays a pivotal role in navigating day-to-day occurrences. Cultivating critical thinking demands deliberate attention and consistent practice, as emphasised by Byrne and Johnstone (1987).

Central to understanding critical thinking is the recognition that as human beings, we often instinctively uphold our own perspectives while shying away from introspection and alternative viewpoints. An integral aspect of personal development involves the willingness to acknowledge mistakes, rectify wrongdoings, and even alter one's course of action accordingly. This transformation towards becoming a well-rounded individual hinges on the capacity to embrace humility and openness to change.

This paper arises from an international collaboration involving researchers from four distinct teacher training institutions: one located in Mauritius and three situated in Maharashtra, India. Within this study, we have embraced the comprehensive definition of critical thinking advocated by Scriven and Paul (1987). In accordance with their perspective, critical thinking is delineated as follows: Critical thinking is the process of intellectual discipline characterised by the active and skillful conceptualisation, application, analysis, synthesis, and/or evaluation of information derived from, or generated through, observation, experience, reflection, reasoning, or communication. Its purpose is to serve as a guiding framework for belief-formation and decision-making.

The primary objective of this study is to ascertain the extent to which pre-service and in-service trainees demonstrate critical thinking within real-life contextual scenarios. Additionally, this research aims to investigate the influence of employing scenarios as pedagogical tools to nurture and perpetuate the development of critical thinking skills among learners.

Review of Literature

Although critical thinking is recognised as being an important educational objective, there is compelling evidence (Ramma, et al., 2021; Koklukaya & Demirhan, 2014; Herreid, Schiller, & Herreid, 2012) which demonstrates that a significant number of university graduates, on conferment, do not possess the ability to think critically. Such a claim has important ramifications, not only for the graduates themselves, but also for the faculty and the university. In a recent article, Burton, Faller, Haniki & Ntshoe (2022, p. 24) found from respondents that “our students are not well-prepared …, and we must ask whether our institutions are providing appropriate support, to address this challenge”. The latter also point out that we can have graduates with strong technical skills but with inadequate critical thinking ability. The ability to think critically entails a process whereby the thinking should

be reasonable, reflective, and should be aimed at deciding what to believe and what to do (Ennis, 1987). In short, critical thinking is "goal-directed, aimed towards an end, and purposeful" (Davies, 2015, p. 45). According to Davies (2015), critical thinking entails skills as well as dispositions and attitude. Thus, for completeness, critical thinking encompasses the cognitive, psychomotor, and affective domains. Any logical decision has to be accompanied by a set of arguments, justifications or reasons.

Thinking is subject/content specific, geared towards a particular situation and thinking critically is linked with something. McPeck (2017, p. 4) argues that "thinking is always thinking about X, and that X can never be 'everything in general' but must always be something in particular". The author further persuasively maintains that critical thinking must also be related to something and that the adjective 'critical' refers to a kind of thinking and that someone who has the ability to think critically in one area might not necessarily be able to do so in another area. There are a number of factors associated with this situation. Snyder and Snyder (2008) explain that much emphasis is laid on transfer of knowledge (content) rather than on the process of how learners assimilate the lesson. More weight has to be placed on teaching learners how to think rather on what to think (Clement, 1979) as it is the application of the content through instructional strategies that engages learners in critical thinking (Snyder & Snyder, 2008). In addition, students should be intrinsically and extrinsically motivated in their teaching-learning environment to develop the propensity to exercise critical thinking in whatever tasks they are engaged in. Bryne and Johnstone (1987) concur that propensity can be instilled in learners when teachers harmonise a course with practical problems which are directly related to application of the concept to real life.

Everyday life occurrences are complex in nature and require someone to identify links between ideas or concepts in a wholistic manner to be able to solve a problem. As mentioned by Bloom (1956) and Wiggins & McTighe (1998), just memorising concepts will not be enough, we need to move to other levels above knowledge, and these are aspects of critical thinking. Learning concepts in a segregated manner will not only complicate matters but also cause confusion in the mind of learners. Similar concepts, for instance, the science concept 'Power' when discussed in the English and in science lessons, if not dealt with, may lead to confusion in the mind of learners. Chrzanowski et al. (2018) argue that any discrepancy between language concepts and similar science concepts taught to students can cause difficulties and eventually impede teaching and learning. Similar situations are observed in other areas as well. Though it is an undeniable fact that critical thinking is important in the school curriculum, it, however, does not form part of the teaching-learning strategies adopted at the elementary and secondary levels of education (Kurfiss, 1988, p. xv). Furthermore, the evaluation of critical thinking poses a formidable obstacle, a challenge acknowledged by Burton, Faller, Haniki & Ntshoe (2022).

Learning outcomes, classified in the form of taxonomy, involve three distinct areas - cognitive, psychomotor and affective domains. The cognitive domain refers to a conscious intellectual activity while the psychomotor domain relates to motor action following a mental activity. On the other hand, the affective domain which relates to feelings, values, attitude, behaviour and emotions is the least considered domain on learning during lessons (Tan, Heng, & Tan, 2013; Shephard, 2008; Ennis, 1987) and assessments (Saxon, Levine-Brown, & Boylan, 2008; Oppong, 2014; Forrest & Blick, 2017). The dismissal of the affective domain is not new as claimed by Noddings (1996) that affect has been neglected in education and this neglect reduces the engagement of both students and teachers in their studies. Furthermore, Shephard (2008, p. 88) emphasises that the affective domain: "… includes, in a

hierarchy, an ability to listen, to respond in interactions with others, to demonstrate attitudes or values appropriate to situations, to demonstrate balance and consideration, and at the highest level, to display a commitment to principled practice on a day-to-day basis, alongside a willingness to revise judgement and change behaviour in the light of new evidence". The dynamic interplay between critical thinking and social skills assumes a pivotal role in the realm of education. This significance is underlined by the fact that successful learning frequently necessitates collaborative endeavours among students, enabling them to manifest creativity collectively. Additionally, it is imperative to recognise that critical thinking assumes a central role in shaping affective control (Esmaeili & Bagheri, 2015; Bareviciute, Dadelo, & Asakaviciute, 2023) thereby providing a foundation for fostering creativity.

Methods

Design Framework

A framework, initially formulated by Ramma and colleagues (2021; 2023), and subsequently refined in their later works has laid the groundwork for identifying and assessing participants' intrinsic critical thinking skills within their reasoning processes. This framework employs scenarios as a conduit to encapsulate the essence of critical thinking. Within these scenarios, tangible real-life problematic situations are presented. Participants are then tasked with applying the conceptual knowledge they have acquired from the subjects they have engaged with, in order to effectively address these challenges. The assessment of critical thinking is guided by a set of criteria closely aligned with factual, conceptual, and procedural knowledge (Table 1), as well as the ability to draw meaningful conclusions (Braithwaite & Sprague, 2021; Antharjanam, 2021).

Knowledge Category	Key Criteria
Factual Knowledge The basic elements that must be known about a discipline. It includes isolated pieces of information.	Based on verifiable information and empirical evidence. Can be easily checked for accuracy and correctness. Generally accepted as true within a specific domain or discipline.
Conceptual Knowledge The interrelationship among the basic elements within a broader context that enables them to function harmoniously as a whole.	Understanding of abstract concepts, principles and theories. Comprehending underlying frameworks and structures. Recognising and identifying patterns and generalisations.
Procedural Knowledge (*Logical and Analytical*) The ability to perform tasks using skills, algorithm, techniques and methods.	Knowing how to perform specific tasks, actions or procedures. Following established rules or algorithms. Identifying cause-effect relationships and drawing logical inferences. Applying critical thinking and problem-solving strategies.
Metacognitive Knowledge Knowledge of cognition as well as awareness of one's own cognition.	Awareness and understanding of one's own thought processes and biases. Ability to monitor and regulate cognitive processes. Being conscious of one's own learning strategies and approaches.

Drawing Conclusions	Synthesising information from various sources and perspectives. Evaluating the credibility and reliability of sources. Applying logical reasoning and critical thinking. Considering potential implications and consequences.

Table 1: Knowledge Category and Key Criteria

Procedure

The revised Bloom's Taxonomy (Krathwohl, 2002), in conjunction with Figure 1, serves as a tool to meticulously identify components of critical thinking within participants' cognitive processes as illustrated in Figure 1.

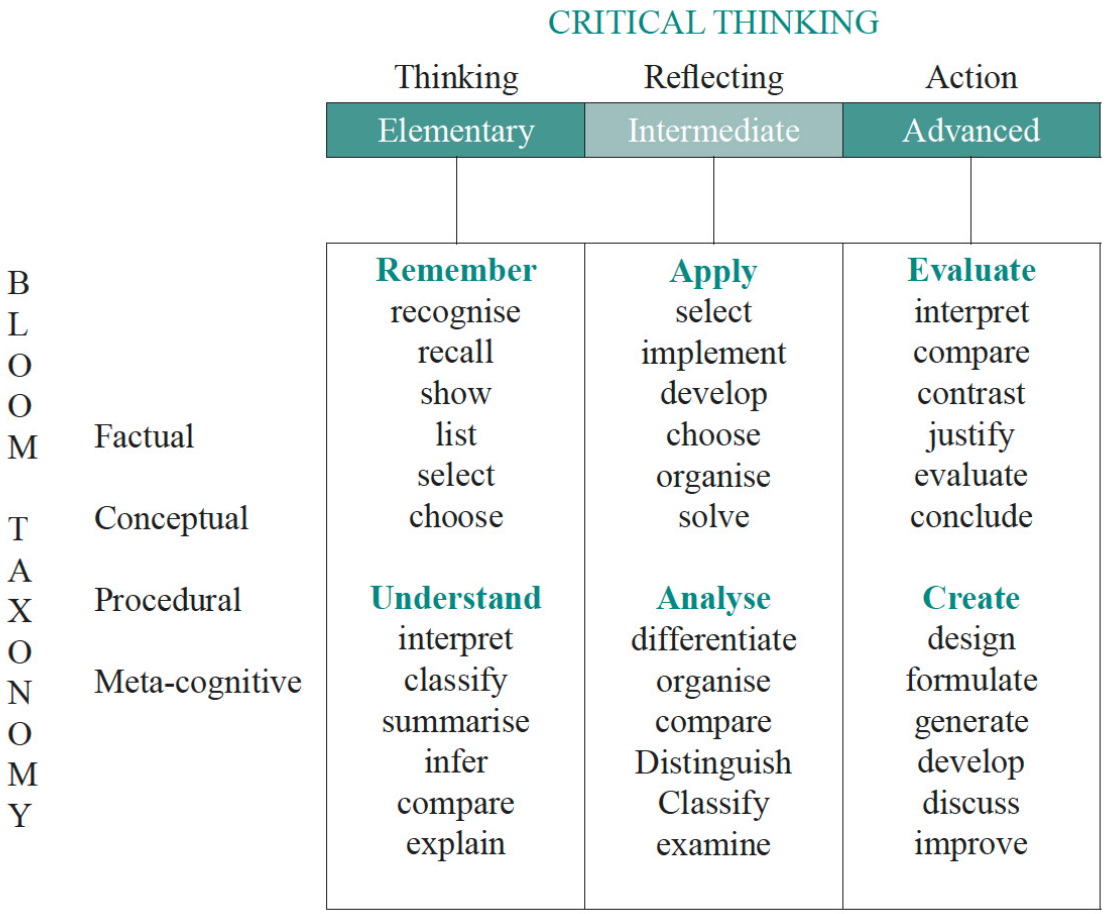

Figure 1: EIA-CT[1] Framework for Assessing Critical Thinking

As an example, the scenario depicted below encompasses three elements: Thinking, Reflecting, and Action (adapted from Barnett, 1997). In the pursuit of identifying critical thinking, these elements are segmented into *elementary*, *intermediate*, and *advanced* stages, forming a comprehensive and interconnected framework:

[1] Elementary-Intermediate-Advanced Critical Thinking

At night, you wake up suddenly, feeling thirsty. However, you realize that there is no power, and you are surrounded by total darkness. You cannot locate your mobile phone to use its flashlight, and regrettably, there is no other source of light in the room. You decide to tread carefully to the kitchen in search of a matchbox, aiming to find some light that will enable you to pour water into a cup for drinking. While entering the kitchen in darkness, you unexpectedly slip and fall onto the floor. What crosses your mind at that particular moment while you lie on the floor? Enumerate all the thoughts that occur to you. For each of these thoughts, how do you endeavour to verify their validity, if at all? What actions do you envision taking to be better prepared for facing such a situation in the future?

Participants

The participants comprised pre- and in-service trainees who were enrolled in Postgraduate Certificate in Education and Bachelor's in Education programmes from Mauritius and India. A comprehensive assessment, consisting of a pre-test and a post-test, was conducted among the participants in the two distinct countries: designated as Country X (with a sample size, n = 75) and Country Y (with a sample size, n = 55). The use of the placeholders X and Y ensures the anonymity of the respective countries involved in the research. The post-tests were conducted after three-day workshops on critical thinking and its assessment held in both countries. All necessary ethical protocols were adhered to before collecting data. Furthermore, the participants were informed of their option to withdraw from the study at any time without facing any repercussions on their studies.

Tools for Data Analysis

An illustrative power outage scenario was initially introduced, following the model by Ramma et al. in 2021. Subsequently, an in-depth workshop was conducted to foster comprehensive discussions encompassing all components of the framework and what information in relation to critical thinking were expected. The data collection process involved utilising Microsoft Forms within the Office 365 suite to gather information from both pre- and post-test stages. For data analysis, Microsoft Excel was employed. In terms of participants' feedback, the primary author was responsible for assigning scores based on the identification of critical thinking elements, as depicted in Figure 1 and elaborated in Table 2. Subsequent to this initial scoring, a meticulous review was undertaken, and the scores were further refined. Validation of these scores was then carried out collaboratively by the remaining co-authors. To provide a concrete example, Table 3 showcases a representative participant's response alongside the corresponding assigned scores.

Process of Criticality	**Critical Thinking Stage**	**Description & Rubrics [an insight]**	**Assessment Rubrics [some examples]**	**Marks**
Thinking	**Elementary** [What is the issue/dilemma?]	Am I hurt? How do I confirm that I am not hurt?	• Yes I'm hurt • No I'm not hurt; If so, I call for help etc.	

Reflecting ***(During the reflection phase, ideas from thinking phase may be reviewed.)***	**Elementary** [What course of action to follow?] **Intermediate** [How to confirm the premises? What to conclude?]	What do I do after confirming that I got/did not get hurt? What is the cause of this mishap? How do I confirm any premises?	• To confirm by using the sense of sight/touch and to proceed depending on the outcomes. • I have fallen most probably because of water spillage; worn out slippers; I've not worn out slippers at all and the floor was slippery. The sense of touch may be helpful. • If not injured, to look for a source of light or to seek help?	0 – not present ½ – partially present 1 – adequately present
Action ***(During the action phase, ideas from reflection phase may be reconsidered)***	**Intermediate Advanced** [If the issue is within my reach, how to proceed to solve it? If not, what alternatives exist?]	What can I do to avoid such a situation in the future? What other alternative(s) exist to minimise such incidence? Where do I get help if necessary?	• To ensure that the floor is clean and dry before going to sleep. • When waking up, to use a source of light. • To walk carefully.	

Table 2: Key Elements for Assessing Critical Thinking

Stages of Critical Thinking	**Thinking**	**Reflecting**	**Action**
i) *I wonder if I have been injured and how did I slip as I was walking carefully.* *ii) I tried to get up and check if there is any part of my body that has been hurt then I noticed it was a leaking roof that led to a slippery floor.* *iii)To always keep my phone near my bed so as to have the flashlight and also I can bring a bottle of water in my bedroom so that whenever I'm thirsty it will not be necessary to go to the kitchen.*	1	1	0.5

Table 3: Response and Subsequent Marking

Data Analysis & Discussions

In this section, we present and analyse the outcomes of the Friedman tests, which were conducted to examine variations in three distinct categories of critical thinking: "Thinking," "Reflection," and "Action," between Country X and Country Y. These tests were conducted using pre-intervention and post-intervention data. The initial data collection involved obtaining pre-test data from participants in two different countries: Country X (n = 75) and Country Y (n = 55). Specifically, for the post-test data, the sample sizes were: Country X (n = 27) and Country Y (n = 30). This discrepancy in sample sizes can be attributed to the non-participation of some individuals in the workshop, leading to their exclusion from the post-test analysis. The Friedman test was employed to assess the existence of statistically significant differences among dependent samples within each location. For both Country X and Country Y, the test aimed to confirm or refute the null hypothesis (H_0) that there were no significant differences among the three dependent categories ("Thinking", "Reflection" and "Action").

Results: ***Pre-test Analysis***

The pre-test results indicate that both Country X and Country Y displayed statistically significant differences among the critical thinking categories of "Thinking," "Reflection," and "Action." The low p-values (<0.0001 for Country Y and < 0.0025 for Country X) (see Table 4) signify that at least one category significantly deviates from the others within each country.

Country	$\chi^2_{(2)}$	p value	Conclusion
X ($n = 75$)	11.95	0.0025	Reject H_0
Y ($n = 55$)	29.85	0.0001	Reject H_0

Table 4: Friedman tests pre-test results

When examining the critical thinking categories within the pre-test data, a nuanced interpretation comes to light as we delve into the medians of these distinct categories across participants from both Country X and Country Y (refer to Figure 2). The pre-test data collected from participants in Country X reveals a median score of 0.5 in the "Thinking" category, suggesting a well-balanced distribution of cognitive engagement in this aspect among the participants. However, in the categories of "Reflection" and "Action," both medians are recorded at 0, indicating that half of the participants from Country X demonstrated minimal inclination towards either reflective or action-oriented critical thinking during the pre-test phase. Conversely, the pre-test data gathered from participants in Country Y portrays distinctive medians across the critical thinking categories. Once again, the median score of 0.5 in the "Thinking" category suggests a well-rounded participation in this cognitive domain. Yet, in the "Reflection" category, the median score of 0.5 emphasises that half of the participants showcased a propensity for reflective thinking. Moreover, the median score of 0 in the "Action" category signifies that half of the participants displayed limited engagement in action-oriented critical thinking during the pre-test phase.

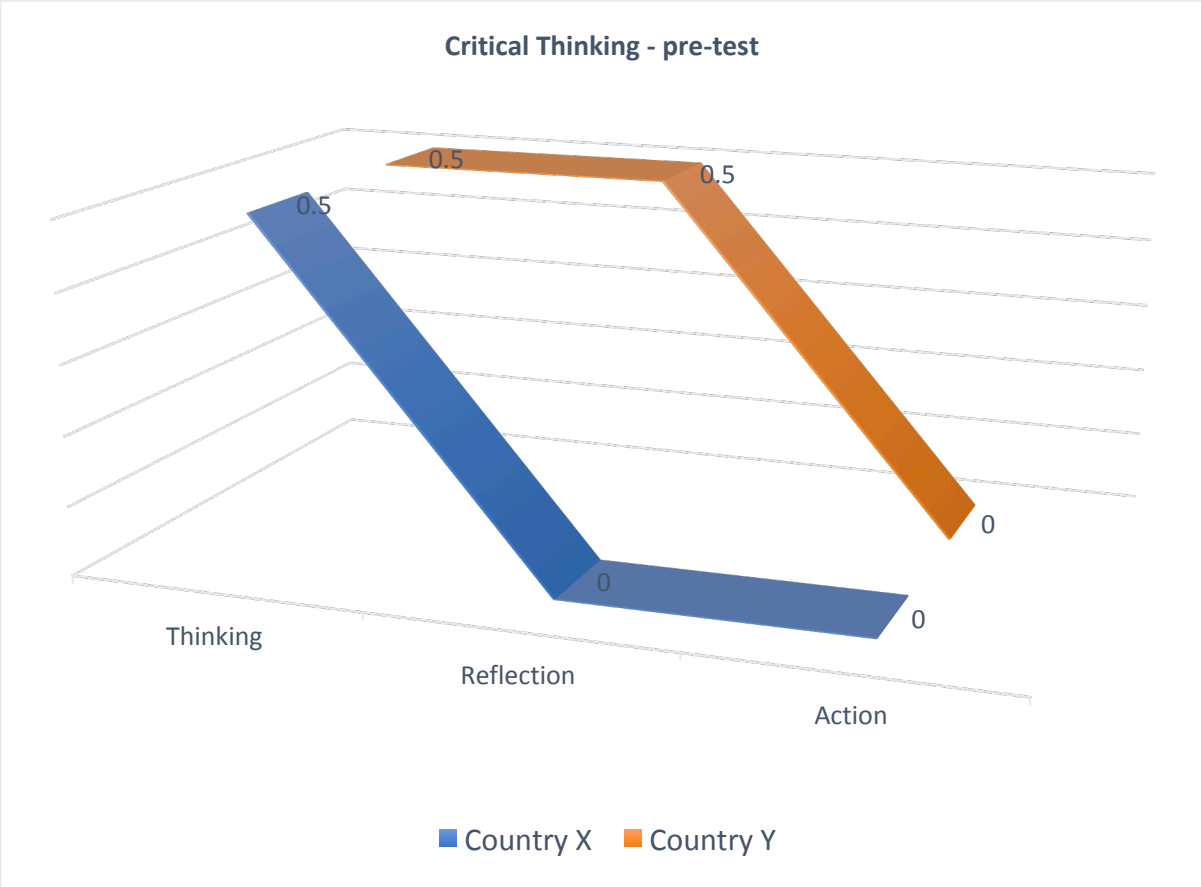

Figure 2: Pre-test median scores comparison

Post-test Analysis

In the post-test phase, both countries' critical thinking categories underwent evaluation for any significant changes (see Table 5). For both Country X and Country Y, the observed p-values exceed the significance threshold of 0.05. Consequently, in both cases, the null hypothesis (H_o) is retained, suggesting that no statistically significant differences were detected among the critical thinking categories after the intervention.

Country	$\chi^2_{(2)}$	p value	Conclusion
X ($n = 27$)	3.722	0.9272	Do not reject H_0
Y ($n = 30$)	0.15	0.1555	Do not reject H_0

Table 5: Friedman tests post-test results

In the post-test phase, the critical thinking categories of both countries were assessed for any notable changes, as outlined in Table 5. For both Country X and Country Y, the calculated p-values surpass the established significance threshold of 0.05. As a result, in both instances, we uphold the null hypothesis (H_o), indicating that no statistically significant differences were observed among the critical thinking categories after the intervention.

Notably, while the median score of 0 remains consistent in the "Action" category, it is important to emphasise that this suggests that half of the participants continued to display minimal engagement in action-oriented critical thinking even after the intervention. For Country Y, the post-test medians demonstrate significant consistency with the pre-test

medians across two out of the three critical thinking categories. The sustained median score of 0.5 in the "Thinking" and "Reflection" categories underscores a steady level of engagement in cognitive processes pertaining to these facets. Conversely, the post-test median score of 0.5 in the "Action" category highlights an encouraging shift from the pre-test, suggesting that a subset of participants from Country Y exhibited improved engagement in action-oriented critical thinking (see Figure 3) following the intervention.

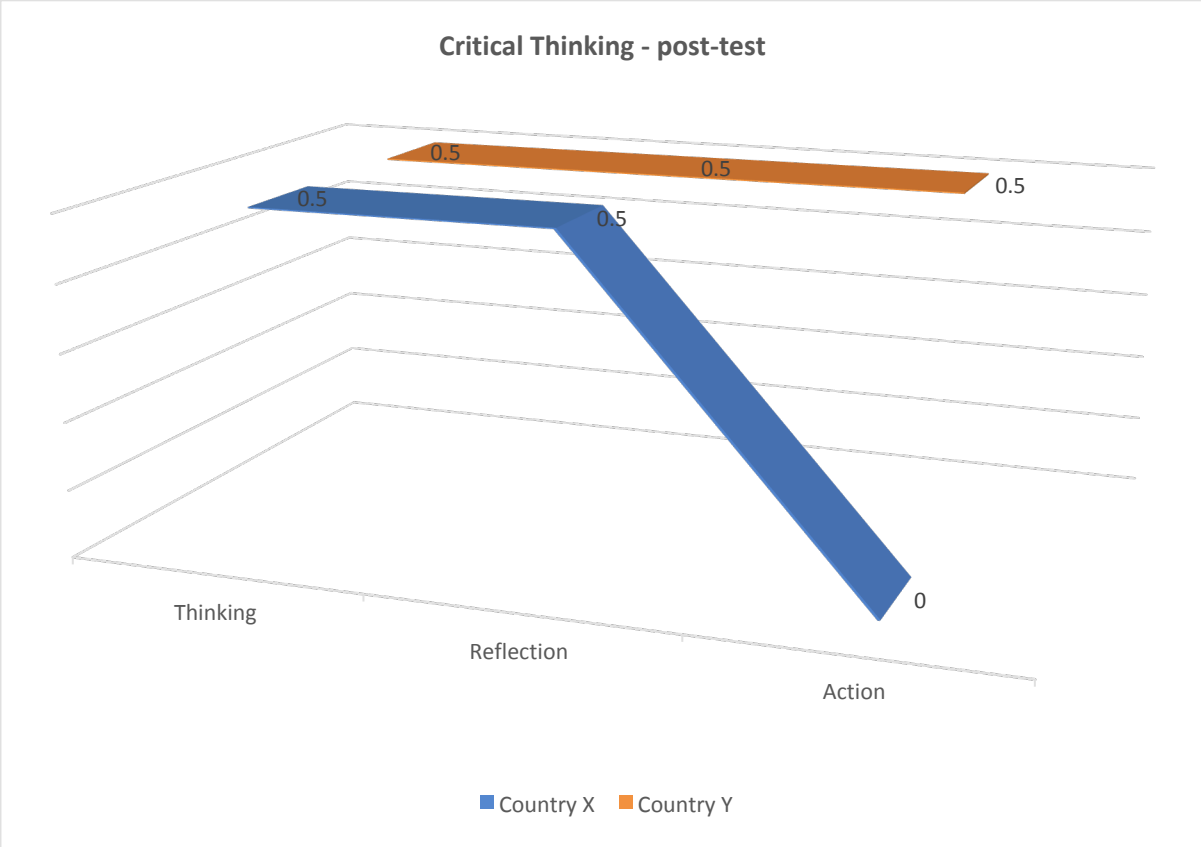

Figure 3: Post-test median scores comparison

Conclusion

This study has illuminated the intricate and nuanced nature of critical thinking within educational contexts. Through an examination of pre-test and post-test data collected from two distinct countries, namely Country X and Country Y, the study has uncovered diverse cognitive tendencies and the measurable effects of interventions on various dimensions of critical thinking. The results underscore a substantial disparity in the critical thinking abilities of trainees within both countries. Extensive research (e.g., Kurfiss, 1988; Ramma et al., 2021) consistently underscores the paramount importance of nurturing critical thinking skills among learners. This cultivation is best achieved by creating conducive learning environments that not only foster skill development but also minimise unnecessary constraints that could impede intellectual growth. The insights gleaned from this study underscore the pressing need for tailored educational approaches that account for the intricate interplay of cultural, cognitive, and contextual factors. Significantly, the findings from this study highlight the efficacy of targeted interventions in catalysing shifts in critical thinking profiles. Particularly noteworthy is the role of metacognitive skills in facilitating these transformative changes. As a result, educators and educational institutions are advised to

emphasise the cultivation of metacognitive abilities as a central tenet of their instructional strategies.

Thus, this study provides an in-depth comprehension of critical thinking within educational settings, shedding light on the impacts of interventions and the complexities of cultural and cognitive nuances. These implications extend beyond the confines of the study, urging a comprehensive reevaluation of pedagogical practices. Educators must prioritise not only the transmission of factual knowledge but also the fostering of critical thinking skills and metacognitive awareness. Curricula and teaching methodologies must evolve to encompass the multifaceted dimensions of critical thinking across diverse cognitive domains.

By championing a culture of active reflection, open-mindedness, and adaptable problem-solving, educational systems can significantly contribute to nurturing individuals who possess the acumen to navigate the intricacies of the modern world. Critical thinking transcends mere academia; it transforms into a lifelong skill that empowers individuals to make informed choices, engage in constructive discourse, and meaningfully enrich society. As educators and learners alike recognise the inherent value of critical thinking, it solidifies its place as an indispensable cornerstone of holistic education and personal growth.

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