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The Effect of Gender on the Relationship between Critical Thinking and Pattern Recognition: Students' Perspectives

Daniel Ling
Asia e University, Malaysia

Sau Cheong
University of Malaysia, Malaysia

Abstract

The purpose of this study was to examine qualitatively the factors that could influence the effect of gender on the relationship between critical thinking and pattern recognition of Singapore private school students. Interviews were conducted with 11 private school students to seek their opinions. The participants, age 16 to 19 including six males and five females, were students recruited from three private schools in Singapore. All the interviewees had enrolled in the General Certificate of Education 'O' level preparatory courses. The interview transcripts were analyzed using Qualitative Data Analysis Miner software. The majority (64%) of the interviewees agreed that gender influences the relationship between critical thinking and pattern recognition. Two primary themes were identified that influenced the effect of gender: the internal character traits of a person and external factors such as influences from society. Three recommendations based on findings include examining the impact of various internal character traits in more detail, including interviews from school teachers and administrators to obtain insights from other stakeholders in the learning context. Finally, a mixed-method sequential explanatory design could be used to further examine the effect of gender.

Keywords: critical thinking, interviews, gender, pattern recognition, qualitative study

Introduction

Critical thinking and cognitive pattern recognition are the two important

cognitive skills essential for academic success (Claessens & Engel, 2013; Karbalaei, 2012). Cognitive pattern recognition is defined as the ability of the person to recognize patterns through the use of prototype-matching, feature-matching, and sequence-matching skills (Ling, 2020), and critical thinking is the cognitive ability of an individual to engage in the intellectual process of making critical reasoning through induction, deduction, identifying assumptions and evaluating the credibility of statements (Ling, 2020).

A recent study conducted by Ling and Loh (2020) on Singapore private school students showed a significant relationship between critical thinking and cognitive pattern recognition among the students. Other past studies also support this important relationship such as the use of Benner's Theoretical Framework by Wilgis and McConnell (2008) for nurse education, and the study by Harris and Spiker (2012) on intelligence analysis, which identify the ability to recognize patterns and relationships as one of the critical thinking skills. With this understanding, the next step is to identify and examine any external variables which could affect the relationship between the two cognitive abilities. Based on past studies, it was found that gender is a factor that influences the relationship between critical thinking and pattern recognition of the students (Brandner & Devaud, 2013; Rodzalan & Saat, 2015).

The purpose of this study was to examine qualitatively the factors that could influence the effect of gender on the relationship between critical thinking and pattern recognition of private school students who were studying in Singapore General Certificate of Education (GCE) 'O' level preparatory courses. The private school students were made up of four main categories. The first group of students was the international students and the second group comprised local students who had sat for the GCE 'O' level examinations but wanted to have a second attempt. The third group of students was from the 'N' level stream who wished to sit for the 'O' level examinations as private candidates. The fourth group of students was the adult learners who decided to resume their studies for better prospects (Ling & Loh, 2020).

The rationale of the study was a need to seek a deeper understanding of the factors that could influence the effect of gender on the strength of the relationship between critical thinking and pattern recognition through the students' perspectives.

In this way, schools would be in a better position to decide on curriculum planning and, if necessary, teachers could carry out differentiated teaching between the two genders. Using a qualitative study approach with short interviews, the researchers attempted to uncover the possible factors during the interview sessions.

Singapore private school students who enrolled in the GCE 'O' level preparatory courses were chosen for this study due to the reason that they generally did not fare as well as their public school counterparts in academic studies (Ang, 2019; Ang, 2020; Ling & Loh, 2020). The authors feel that more research needs to be done on this group of students to improve their academic performance at the national examinations.

Research Objective

The objective of this study was to seek students' perspectives towards the effect of gender on the relationship between critical thinking and cognitive pattern recognition through a qualitative approach.

Research Questions

1. In what ways does gender affect the relationship between critical thinking and pattern recognition?
2. What were the internal and external factors (if any) that influence the effect of gender on the relationship between critical thinking and pattern recognition?

Literature Review

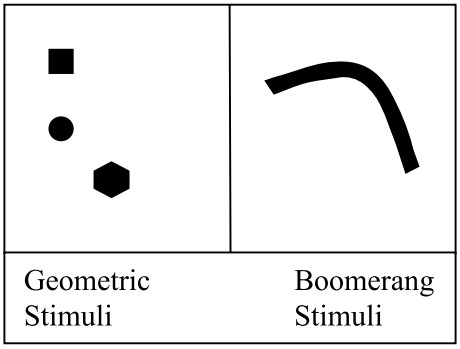
In a study conducted by Rodzalan and Saat (2015) with 2000 undergraduate students in Malaysian public universities, students were required to answer 11 statements concerning critical thinking and problem-solving skills. The statements were adopted from the Belbin Team Role Self-Perception Inventory (Belbin, 2013). The study found that male students were generally better at critical thinking and problem solving than their female counterparts. One strategy of problem-solving was the use of pattern recognition (Matthee & Turpin, 2019), where the correct solution was creatively identified through the matching of the different possible

solutions (patterns) that best solved the problem (Simonton, 2009; Hong, 2013). The above study revealed a difference in how the two genders executed critical thinking and problem-solving (pattern recognition) skills, indicating that gender could affect the relationship between the two cognitive abilities.

In another project by Brandner and Devaud (2013) conducted with 30 volunteers recruited from the University of Lausanne, Switzerland, the interviewees were required to recognize rotated patterns under timed conditions. The study comprised two experiments. In the first experiment, participants were shown geometric-shaped stimuli in the forms of a circle, a hexagon, and a square with different angles of rotation, while in the second experiment, the stimuli were changed to boomerang-shaped (Figure 1). At the end of the study, it was found that men were more likely to identify the correct rotated patterns (target and lure stimuli) than women in the geometric-shaped stimuli. However, when geometric-shaped stimuli were replaced by boomerang-shaped stimuli, this gender difference was no longer significant. This indicated that men's better performance in the first experiment was attributed to their better critical thinking skills to convert a geometrical problem requiring mental rotation into smaller and simpler components by focusing more on the geometry of the environment (Brandner & Devaud, 2013). But this approach did not work very well when the type of pattern changed to a non-geometrical one.

Figure 1

Geometric-Shaped Stimuli and Boomerang-Shaped Stimuli



Factors Influencing Effect of Gender

It was also essential to look into past studies that used gender to study

relationships between variables and discuss the factors that could influence the effect of gender between the variables.

In the study conducted by Chen et al. (2019), gender was found to influence the relationship between depression and adolescent smoking behavior. The authors highlighted that in dealing with the effect of gender as well as the smoking behaviors of male and female teenagers, it was essential to consider the different psychological features between male and female teenagers; in particular, more attention should be focused on the varying emotions of female teenagers (Chen et al., 2019). This showed that emotional fluctuations could affect the influence of gender in the study.

In another study done by Yang et al. (2019) on the impact of gender on the relationships between social support networks, user engagement in health tasks, and user health conditions (Yang et al., 2019), the researchers cited that gender-based difference could be classified into three levels – biological, cognitive and social & behavioral (Sun et al., 2010; Yang et al., 2019). Specifically, the differences in the biological features at the chromosomal and hormonal levels led to gender differences at the cognitive, and social, and behavioral levels. This indicated that biological factors could influence the effect of gender (Sun et al., 2010; Yang et al., 2019).

In addition, Narayanasamy et al. (2011) conducted individual interviews with 21 entrepreneurs (10 males and 11 females) who have businesses on hand in Malaysia. Two of the objectives in the qualitative study are: to identify whether gender difference is a key factor for a company and to better understand the different styles that men and women adopted as entrepreneurs. The study revealed that characters and personality, family and social background, education levels government policies, and capability are factors that contribute to gender differences in entrepreneurship. In particular, characters and personality (internal character traits) and family and social background (external factors) have been identified as the over-arching themes in this study based on the analysis of the interview data.

Noticeable gender differences could also be due to differences in historical expectations between males and females. The study of social factors influencing the effect of gender is not a new thing. In an earlier article written by Eagly (1983), the author mentioned that men are regarded to naturally exert more influence while

women are thought to be more easily influenced. According to Eagly, this difference came mainly from 'formal status inequalities', where men have a greater chance of gaining higher social status than women (Eagly, 1983). Many years later, Carli (2001) wrote that in general, men exercise larger influence as compared to women. This is attributed mainly to gender stereotypes that classify men to be more capable than women, and also the societal expectations that women need to be more self-sacrificing and obliging than men (Carli, 2001). Social factors and expectations play a major role in how each gender performs.

Methodology

The Participants

For a small qualitative research project, Braun and Clarke (2013) recommend a sample size of six to ten participants for interviews. The study conducted by the authors to write this paper was regarded as a small project of thematic analysis (Maguire & Delahunt, 2017), which was used to identify the overarching themes of the factors that could influence the effect of gender on the relationship between critical thinking and pattern recognition. Hence, short individual semi-structured interviews (between 5 to 15 minutes in length) were conducted with a purposively selected sample of 11 students from three private schools in Singapore. The purposive sampling method is used as the private school students can provide the most relevant and ample data for this study (Yin, 2016).

The participants were recruited through extending of invitation via personal and professional networks of the researchers. All the participants had enrolled for the GCE 'O' level preparatory courses in Singapore private schools either in 2018 or 2019. The majority (73%) of the participants came from P College, with two (18%) from B Academy and one (9%) from S Institute. Among the 11 interviewees, six (55%) were boys, and five (45%) were girls. Six of the interviewees were willing to reveal their age range from 16 to 19 years old.

Ethical Concerns

At the beginning of the interview, each interviewee was asked for their consent to be interviewed and for the conversation to be audio-recorded. The purpose of the study was shared with participants and they were assured that their details would be kept strictly anonymous and confidential. All interviewees gave

their verbal consent. Instead of signed parental consent forms, each interviewee was required to inform their parents or guardian about the interview. The parents or guardians were welcome to contact the researchers to clarify or raise any concerns about the interview. Parental consent was deemed to have been obtained when there was no contact made or objection highlighted by any parent or guardian with the researchers. At the end of the qualitative data collection process, there was no contact made by any parent or guardian about the conduct of the interview for their child or ward. Verbal checks with the various interviewees after the interviews have also confirmed that they had informed their parents about the interview.

In addition, the name of each interviewee and the contents of the interview only existed in the audio-recorded file and the transcript, which could only be accessed by the researcher and the supervisor. The discussions of the interview contents would only contain the abbreviated names to distinguish between different interviewees while keeping their identity confidential.

According to the school of graduate studies where the research was conducted, ethics approval from the department was not required as long as informed consent had been obtained from the participant, a conscious effort was made to maintain the confidentiality of the data and that the project presented a minimal risk to the participants [the nature of the interview for this study is considered a minimal risk as the probability and magnitude of harm are not greater than those encountered in daily life]. Hence, institutional guidelines were followed to ensure the anonymity, confidentiality, and safety of the participants.

Procedures

After the ethical issues were addressed, individual interviews were conducted either through phone or through face-to-face meetings at places preferred by the interviewees. The conduct of interviews is chosen as the research tool for this study because the researchers wish to obtain a deeper understanding of the influence of gender on the relationship between critical thinking and cognitive pattern recognition based on the opinion of the students. Another qualitative research tool, the use of a focus group, is not suitable due to two reasons. First, the conduct of a focus group can lead to a loss in depth and anyone or two interviewees who are more out-spoken may dominate the session (Yin, 2016). Second, the students come from more than one school, and it is very difficult to arrange for a common time

slot where most or all of the interviewees are available for the focus group session. A sample of the interview questions has been included in appendix A.

Interviews lasted for up to 15 minutes in length, with the contents of the interviews audio-recorded and subsequently converted into transcripts. The transcripts were then sent back to each interviewee for their reviews and amendments if necessary.

Data Analysis

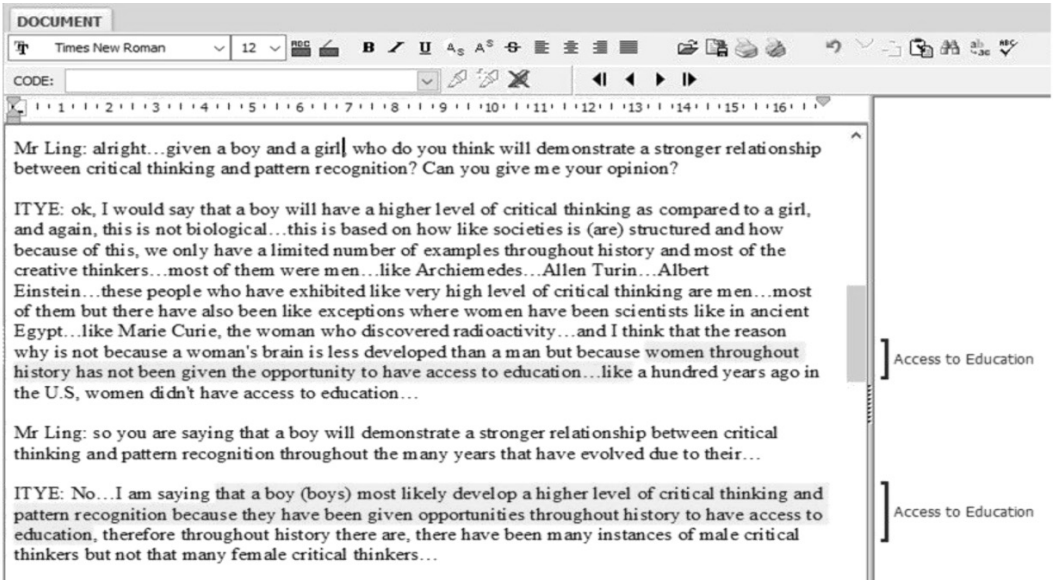
To assist the researchers with the qualitative data organization, the software Qualitative Data Analysis (QDA) Miner Lite was used. QDA Miner Lite is free software that could organize and analyze textual data such as content from interviews or news transcripts (Provalis Research, 2019).

The qualitative data obtained from the transcripts were first loaded onto the QDA Miner Lite platform. The various transcripts were separated into different cases (11 cases for 11 interviews). The next step was to develop the codes that can be assigned to the various segments of each case. Codes were short descriptive words used to describe particular phrases in the transcripts that were relevant to answering the interview questions.

Each code was allocated a different color to differentiate between codes for each case. In Figure 2, the panel presented part of an interview transcript. The segments which had been allocated codes were highlighted. The right panel showed the various codes which had been assigned to each segment in the transcript. At the end of the coding process, all eleven cases were allocated codes accordingly.

Figure 2

Assign of Codes to Segments of Individual Transcripts



In QDA Miner Lite, the codes could be easily retrieved for analysis and categorizing purposes. The search function in QDA Miner Lite allowed the researchers to retrieve all the assigned codes' records. For each code, the corresponding category, relevant texts/phrases in the transcripts, the number of words, and the percentage of words were also made available.

Following the above coding procedure, the codes were categorized into themes and sub-themes. The overall picture of the qualitative data was developed by establishing the relationships among the themes. As part of the triangulation process (starting with all the interviewees approving of their respective transcripts), the categorization of the codes into the various themes was sent to a linguistic expert for verification. The codes and themes were also sent to the project supervisor for another round of comments and feedback. The interview contents, the codes, the sorted themes, and the research findings were discussed in the next section.

Findings

The main purpose of this section is to present the qualitative research findings to provide explanations about the factors that could affect the effect of gender on the relationship between pattern recognition and critical thinking. The following results were obtained based on the coding of the data and categorization of the data into themes.

The outcome of the interviews had seven out of the 11 interviewees (64%) indicated that 'Gender' was an influence on the relationship between 'Critical Thinking' and 'Pattern Recognition,' which agreed with the literature reviews. Table 1 presented the distribution of the results.

Table 1

Distribution of Results Based on Qualitative Interviews

Abbreviated Name of Interviewee	School	Does gender affect the relationship between critical thinking and pattern recognition?
Interviewee A.L	B Academy (2018)	No
Interviewee A.S.J.	B Academy (2018)	Yes
Interviewee F.G	S Institute (2018)	Yes
Interviewee R	P College (2019)	No
Interviewee E.C	P College (2019)	Yes
Interviewee M.O	P College (2019)	No
Interviewee I.T.Y.E	P College (2019)	No
Interviewee M.C	P College (2019)	Yes
Interviewee D.F	P College (2019)	Yes
Interviewee D.Y	P College (2019)	Yes
Interviewee K.H	P College (2019)	Yes

After analyzing the transcripts, the interview data of the interviewees, who felt that gender could influence the relationship between critical thinking and pattern recognition, were grouped into two main themes – 'Internal Character Traits' and 'External Factors.' The categorization of the data into these two themes had been done in past studies on other areas. For example, in a study conducted by Narayanasamy et al. (2011) on entrepreneurship, two of the main factors that influence gender difference in entrepreneurship are characters and personality

(internal character traits) and family and social background (external factors). Another paper written by Eagly and Wood (2011) suggested that gender roles are usually 'internalized as personal standards for individuals' behavior' (internal character traits) and these characteristics are often activated to support social-cultural factors (external factors) that guide gender behaviors.

Internal Character Traits

Logical Thinking and Problem-Solving

Interviewee F.G mentioned that boys generally had better critical thinking and pattern recognition skills, predominantly due to their engagement in video gaming activities, which helped shape problem-solving skills.

> *"I think boys have a better relationship between critical thinking and pattern recognition…I think….(giggled)…like boys play more video games compared to girls…and so I think video games improve your ability to solve problems…or to think faster…I think boys are better (at) critical thinking compared to girls, and they (boys) can recognize patterns maybe easily in a way."*
>
> *– Interviewee F.G on 21 Jan 2019*

Interviewee M.C also supported the idea put forward by Interviewee F.G in the area of gaming and sports.

> *"I mean, a boy will demonstrate critical thinking and pattern recognition better than the girl. Because I see most boys love to play games like computer games or sports games such as basketball or soccer. We know they will create the strategies on how to win the game and the match...means they will think critically about the best strategy to win the match."*
>
> *– Interviewee M.C on 13 March 2019*

While both Interviewee F.G and Interviewee M.C agreed that there is a gender difference in the relationship between critical thinking and pattern recognition, with boys being the more dominant gender, Interviewee K.H felt that girls exhibited a stronger relationship between critical thinking and pattern recognition.

> *"I think a girl will demonstrate a stronger relationship between critical*

thinking and pattern recognition compared to a boy…Compared to boys, girls are more likely to use logical and rational thinking to solve problems and to make decisions… they look at things from different angles before concluding."

– Interviewee K.H on 15 May 2019

Interviewee K.H mentioned girls' gender roles in terms of their adaptability as an internal character trait.

"Girls are generally more adaptable to the external environment, especially in the academic world as they are better at using logical and rational thinking (relate to logical thinking)."

– Interviewee K.H on 15 May 2019

Interviewee D.Y also felt that girls are likely to demonstrate a stronger relationship between critical thinking and pattern recognition.

"I would say it's a girl. Because a girl tends to think logically and always has a weighing criterion when it comes to decision making…to ensure that the right or the best decision to make. The same is done with pattern recognition. They will logically think and have some weighing criterion to find the best solution."

– Interviewee D.Y on 3 May 2019

External Factors

Societal Influences and Roles

While there were interviewees who felt that internal character traits were the main drivers showing that gender could influence critical thinking and pattern recognition, another group of interviewees attributed that to *external factors*, particularly the role of gender in society.

Interviewee E. C highlighted this aspect in the interview about boys' gender roles.

"for most boys, their environment will be more centralized on roles that provide them with more critical thinking and pattern recognition kind of aspects."

– Interviewee E.C. on 6 March 2019

Interviewee D.F mentioned the decision-making and leadership roles of men in families, which could influence the relationship between critical thinking and pattern recognition.

> *"I think a boy will demonstrate a stronger relationship between critical thinking and pattern recognition. Men are believed to tap on their logical thinking more than women. This explains why big decision-making in families is usually left for the man, especially in those traditional and conservative Asian families. Men are more likely to use their rationale and extend it to critical thinking."*
>
> *– Interviewee D.F on 2 May 2019*

However, four out of the 11 (36%) interviewees expressed their opinion that gender should not affect the relationship between critical thinking and pattern recognition. Their opinion could also be grouped under the two broad themes of 'Internal Character Traits' and 'External Factors.'

External Factors

Opportunities and Exposures

Interviewee I.T.Y.E gave his opinion that gender biologically did not affect critical thinking and pattern recognition. Rather, it was the opportunities and exposures given to a particular gender (i.e., males) throughout history to have access to education that helped them achieve a stronger relationship between the two variables.

> *"I am saying that a boy (boys) most likely develop a higher level of critical thinking and pattern recognition because they have been given opportunities throughout history to have access to education, therefore throughout history there are, there have been many instances of male critical thinkers but not that many female critical thinkers"*
>
> *– Interviewee I.T.Y.E. on 24 March 2019*

Interviewee M.O supported the above view in environmental exposure since young, not about gender itself.

"Just that critical thinking requires exposure to solving problems from a young age…"

– Interviewee M.O on 7 March 2019

Internal Character Traits

Perceived Equal Intelligence

Interviewee A.L felt that given the same intelligence, neither one of the genders was able to naturally exhibit stronger critical thinking and pattern recognition over the other. He perceived equal ability between the two genders, assuming both had the same level of smartness.

"It depends on the individual, like, people, I mean there are smart people… .a guy and given that smart a girl…I think both of them can do it…I also believe that both genders can equally do well (for critical thinking and pattern recognition)"

– Interviewee A.L on 19 Jan 2019

Interviewee R gave a slightly more gender-biased opinion, stating that other than when women had their periods, which could cloud their thoughts; gender did not affect the strength of the relationship between critical thinking and pattern recognition.

"I don't feel that gender plays much of a part when it comes to critical thinking. But like for example women go through their periods, so maybe during those times, they may not be able to have a clear thought of what is going on, and maybe they might let their moods cloud them, cloud their thoughts. So other than that, I feel like as I said just now, gender doesn't play much of a part in"

– Interviewee R on 31 Jan 2019

Discussion

The main objective of the qualitative study was to identify the factors that could affect the effect of gender on the critical thinking and pattern recognition of private school students in Singapore. This was done by conducting a series of short individual interviews.

Most interviewees agreed that gender could affect the relationship between critical thinking and pattern recognition of private school students in Singapore. Based on qualitative data analysis, two overarching themes were identified. They were the internal character traits of an individual and external factors such as the environmental influence and roles that society placed on the two genders. Internal character traits included the ability to think logically and problem-solve, which, according to the analysis, described how a person tended to act naturally. The other theme involved the influences of the external environment, which encompassed the roles and expectations that society placed on an individual. For instance, if a male was given many decision-making roles both at home and in school, there was a tendency that develops a strong ability to think critically and to identify trends and patterns around him (Turan et al., 2019).

Not only were the results consistent with the literature review (Brandner & Devaud, 2013; Rodzalan & Saat, 2015), the opinions were also in line with the Societal Role Theory. Social Role Theory was developed by Eagly and Wood (1999), which suggests that the way society allocated the various types of work according to gender created all gender differences in other aspects. For example, traditionally, the income inequality between men and women in many places resulted from men being given more access to education and opportunities to work in society (Razavi, 2016). Adding to the existing literature, the focus of this study is to extract and analyze the opinions of private school students from the age of 16 to 19 years old concerning the influence of gender on the relationship between critical thinking and cognitive pattern recognition. This is an area on which past studies did not focus. The fact that most participants agreed there is a gender difference in the relationship implies the need to consider the effect of gender when designing curriculum and pedagogies to teach higher-order cognitive skills.

Interestingly, in connection with the Societal Role Theory, some interviewees felt that gender did not affect critical thinking and pattern recognition. Among the opinions, two interviewees expressed their ideas that gender, biologically, did not affect critical thinking and pattern recognition. Rather, it was the opportunities and exposures given to a particular gender (i.e., males) to access education that helped them establish a stronger relationship between the two variables (Eagly & Wood, 1999). In a way, the cited factors had rendered support to the idea that gender did have an impact on critical thinking and pattern recognition. It was just not due to

natural or biological factors, but rather more of social or cultural influences (Beall & Sternberg, 1993; Bussey & Bandura, 1999). The external influences offered by society had again played their part in producing the effect of gender.

Conclusion and Recommendations

In this study, qualitative interviews were conducted on 11 private school students who studied in Singapore to prepare themselves for the GCE 'O' level examinations. The main objective of the study was to obtain private school students' perspectives on the factors affecting the effect of gender on critical thinking and pattern recognition. At the end of the study, it was found that the majority of the interviewees agreed that gender did affect critical thinking and pattern recognition. After analyzing the interview transcripts, two main themes were subsequently identified. They were the internal character traits of a person, and the societal roles and influences. While the research findings were in line with earlier studies as discussed in the literature review, the study also added new knowledge to existing literature, particularly when it comes to gender differences in curriculum design and teaching pedagogies of cognitive skills.

The researchers would like to make three recommendations. First, more studies could be done to examine the effect of logical thinking and problem-solving ability between the two genders and how these affect the relationship between critical thinking and pattern recognition. This is because logical thinking and problem-solving have been identified as two sub-themes after analyzing the qualitative data. Second, it is recommended that the interview samples be extended to school teachers and administrators to obtain opinions from professional educators, hence enhancing the credibility of the research findings. Finally, a mixed-method sequential explanatory design (Creswell, 2009) could be used to further examine the effect of gender using a larger sample size and wider age range. This should produce deeper insight and greater credibility on the effect of gender.

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