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Assessment of Senior High School students' earthquake risk perception on their metacognition in Weija-Gbawe Municipality, Ghana

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Abstract

Metacognition studies have focused on the self-awareness, learning process, and outcomes of students, but how earthquake risk perception affects Senior High School students' metacognition is understudied. This study assessed Senior High School (SHS) students' earthquake risk perception and its effects on their metacognition in the Weija-Gbawe Municipality, Ghana. The study used a questionnaire to collect data from 219 students proportionally from three (3) SHS (Ansong Senior High School, Pentecost Vocational Training Institute, and Royals Senior High Schools). Data processing and analysis techniques employed were exploratory and confirmatory factor analysis, the Kruskal-Wallis test, and path analysis respectively. Results showed a high earthquake risk perception among Senior High School students in Weija-Gbawe Municipality. Also, students' risk perception dimensions like anxiety, uncontrollability and exposure statistically significantly affected metacognition. Therefore, the study concludes that, exposure affects senior high school students' earthquake risk perception. In view of this, the National Disaster Management Organization (NADMO) and Ghana Education Service are advised by the study to provide counseling sessions for students as well as earthquake disaster risk awareness programmes for students. The study contributes to literature by providing link between earthquake risk perception and metacognitive functioning among Senior High School students.

Keywords: Metacognition, Earthquakes, Student's perception, Risk perception, Factor Analysis, Weija Gbawe.

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1 Introduction

An earthquake produces metacognition disorders such as stress, anxiety, and depression, which impede students' quality of life (Manzar et al., 2018). It can also cause metacognition impairments, affecting students' brain functioning, learning capabilities, and retention (Tang et al., 2020). However, the effects of earthquakes on the meta-memory and meta-concentration of students can be reduced if schools and countries have a well-documented earthquake disaster preparedness plan.

Globally, the effects of earthquakes on students' metacognition have been recorded in countries like Nepal, Italy, Haiti, Lebanon, Turkey, etc. (Pietro, 2017; Sapkota, 2021). The occurrence of earthquakes in African countries like Algeria, Morocco, and Tunisia and records of earth tremors in Nigeria have resulted in several studies. These include earthquake preparedness, awareness, and perception (Barani et al., 2023; Meghraoui & Pondrelli, 2012). The perception and the fear of earthquake occurrence can impair metacognitive abilities, especially in Africa, where earthquake preparedness is not prioritized. In Ghana, earthquakes and earth tremors have been recorded in some parts of the country (Amponsah et al., 2012), which includes Weija-Gbawe Municipality. Weija-Gbawe Municipality has recorded more than ten earthquakes and earth tremors since 1615 (Ahulu et al., 2018; Ghana Geological Survey Authority, 2020; Amponsah et al., 2020). Per the risk of earthquakes in Weija-Gbawe Municipality, most studies in the area have devoted attention to seismic hazard assessment, risk perception, awareness, and earthquake-disaster preparedness among households (Adu-Boahen et al., 2020; Ahulu et al., 2018; Allotey et al., 2017; Allotey et al., 2010; Amponsah et al., 2020). However, little is known about earthquake effects on senior high school students' metacognition in Africa and Ghana. In Africa, and for that matter Ghana, since earthquakes rarely occur, especially in schools, no attention has been given to the teenagers, especially those in senior high schools.

Senior high school students are one of the specific vulnerable groups to earthquakes, who are in the critical habit development stage and opinion formation of value and life (Wei et al., 2020). This resuscitates the need to monitor their earthquake risk perception on meta-cognition. In addition, senior high school students tend to possess higher levels of cognitive maturity compared to students in junior high school, which makes them more appropriate for self-report surveys that involve reflecting on internal cognitive processes. Furthermore, the unavailability of earthquake risk awareness and preparedness plans makes schools and students more susceptible to earthquake disaster occurrences (Baytiyeh et al., 2018; Elisa et al., 2019). However, the risk of earthquakes on educational institutions and senior high school students in Weija-Gbawe Municipality is not studied. Hence, this study proposed to assess senior high school students' earthquake risk perception and its effects on their meta-cognition and preparedness towards possible future earthquake occurrence.

The study aims at assessing senior high school students' level of earthquake risk perception in Weija-Gbawe Municipality and the effect of earthquake risk perception on senior high school students' metacognition. To achieve the objectives of the study, these questions were set to guide the study. How do senior high school students in the Weija-Gbawe Municipality perceive the risk of earthquakes? How does earthquake perception affect senior high school students' metacognitive abilities? Are there notable variations in earthquake risk perception among students concerning factors like school, class, and age? Assessment of students' earthquake risk perception can help schools, the Ministry of Education National Disaster Management Organization (NADMO), and other educational stakeholders to design suitable earthquake disaster management policies. The study can inform educational stakeholders of the need to protect students' meta-memory and meta-concentration from earthquake risk.

The psychosocial effects of earthquake disasters may cause students not to be able to attend classes or have difficulty concentrating (Bentri et al., 2017). In this study, exposure as an earthquake risk perception is conceptualized as students' experiences, threats, and thoughts about living in active seismic regions. Exposure to earthquake hazards can potentially trigger psychological distress in children and adolescents (Tang et al., 2020). People with high-risk perception consider their region of location as prone to an earthquake compared to other places not closer to them (Series, 2021). Further research suggests that exposure to hazard indirectly informs people's risk perceptions and preventive behavior (Liu et al., 2020) as well as their intentions to visit a specific destination (Koo et al., 2016). Expo-sure to a hazard can influence people's knowledge about the threat (Neill et al., 2016). Exposure to injuries or death could lead to a higher degree of post-traumatic stress disorder (PTSD) (Xu et al., 2016). This may cause emotional and psychological effects like fear, anxiety, and depression. Further, earthquake risk perception causes people to panic and fear (Xu et al., 2016), leading to anxiety and stress and affecting their metacognition.

Anxiety has different effects on risk perception (Oh et al., 2021) as a different emotional response to a specific risk and essentially alters behavioral intention (So et al., 2016). The effects of discrete emotions (fear, anxiety, anger, disgust, and sorrow) on risk perception are positively associated (Yang & Chu, 2016). Cognitive and behavioral patterns suggest pressure can affect perceptions of risk and hazard mitigation behavior (Notebaert et al., 2016).

It is revealed that feelings, emotions, and social norms are likely to impact children's beliefs in catastrophic situations (Yildiz et al., 2020). Risk perception is influenced by internal factors such as emotional and socio-cultural conditions, and how often earthquakes occur affect a person's risk perception (Saepulloh et al., 2021). The anxiety of students influences the fear and the feelings of people during earthquake situations. This has informed how people perceive earthquake situations as uncontrollable at the time of earthquake occurrence.

Earthquakes are perceived as uncontrollable. The study conceptualized uncontrollability as the thoughts or perceptions of students on earthquake situations at the time of their occurrence that go beyond the reasonable control of school managers or heads due to either their negligence or ignorance about disaster management. The perception of students of being vulnerable to disasters can cause a higher uncontrollable risk perception (Mizrak & Aslan, 2020), while those who perceive natural hazards as disobedient are unlikely to prepare ahead of time for them (Baytiyeh & Öcal, 2016); this influences their earthquake risk perception. Risk perception increases if risks are perceived as involuntary, immediate, un-known, uncontrollable, new, dreaded, catastrophic, and severe (Gerber et al., 2019). Students' fear of the uncontrollable earthquake situations also influences their risk perception of the effects of future earthquake occurrences.

Previous studies have found that negative emotions, such as worry and anxiety about earthquake occurrence, increase people's risk perception (Wei & Lindell, 2017). When students think about the effects of earthquakes, such as causing financial damage on campus and constantly feeling that an earthquake will happen to them on campus, their risk perception increases (Mizrak & Aslan, 2020). Another study revealed that risk perception is significantly influenced by the fear of future earthquakes, the expected breakdown of supplies, and the expected damage to house structures (Bin et al., 2022). Earthquake risk perception can be a mental pain that can affect students' metacognition process.

Metacognition refers to a person's awareness and understanding of their cognitive processes (Manzar et al., 2018). Metacognition describes a set of processes an individual uses to monitor ongoing cognition to effectively control their behavior (Rhodes, 2019). Meta-memory and meta-concentration are two significant dimensions of metacognition that underline the achievements of daily activities. People with memory and cognitive deficiencies are more likely to develop a protective attitude to avoid challenging situations, which affects their capability to deal with similar events in the future (Manzar et al., 2018). These attitudes can have a broad detrimental influence on coping with life difficulties and adjustment. Studies have shown how risk perception affected the metacognition process. The effects of mental trauma on students after an earthquake could worsen their academic performance (Pietro, 2017). When the students think that hazards are uncontrollable, they get scared, and their thoughts about the possible disaster occurrence increase (Peng et al., 2017), which can impair their metacognition abilities. Anxiety disorders are fears that may, in some cases, be directly caused by a traumatic event. Still, they do not necessarily have to be associated with an experience of the hazard, which can impair students' ability to concentrate in class (Gerstner et al., 2020). Also, a study has revealed that anxiety variance affects metacognitive belief variables (Wang et al., 2021). Risk perception has been found to affect people's memory (Lanciano et al., 2020). The effects of students' earthquake risk perception demand the need for preparedness towards any future earthquake.

Flavell's Metacognitive Theory (1979) and Cognitive Appraisal Theory (Lazarus & Folkman, 1984) were used to strengthen the study's conceptual rigor. The Cognitive Appraisal Theory by Lazarus and Folkman (1984) provides insights into the psychological framework for understanding how individuals evaluate and respond to environmental threats, such as earthquakes. Flavell's Metacognitive Theory (1979) posits that individuals engage in two key appraisal processes: primary appraisal, where they assess the severity and relevance of a threat (e.g., likelihood of earthquake exposure, potential harm), and secondary appraisal, where they evaluate their ability to cope with or control the threat. In the context of this study, senior high school students in the Weija-Gbawe Municipality cognitively assess earthquake-related risks such as exposure, anxiety, effects, and uncontrollability, and these appraisals shape their emotional and cognitive states. This study's focus on metacognitive outcomes (meta-memory and meta-concentration) aligns directly with the cognitive consequences of risk appraisal. When students perceive high risk and low coping capacity (e.g., uncontrollability), they may experience heightened anxiety, which in turn impairs memory regulation and sustained attention.

On the other hand, if students perceive some control or preparedness, their cognitive functions may remain stable. Thus, Cognitive Appraisal Theory (Lazarus & Folkman, 1984) connects how students think about earthquake threats with their ability to manage their thoughts, explaining how their feelings of risk affect their thinking skills. This connection substantiates the study's hypothesis and provides a deeper understanding of the cognitive mechanisms at play.

The Cognitive Appraisal Theory (CAT) directly shaped both the formulation of the research questions and the subsequent analytical approach. The research questions were framed to reflect how individuals' primary appraisals of disaster risk and their secondary appraisals of coping capacity influence their preparedness behavior. This theoretical orientation guided the specification of the structural model, where latent constructs such as perceived risk, coping appraisal, and metacognition were hypothesized to predict preparedness intentions. In interpreting the path coefficients, CAT provided the explanatory basis: significant coefficients indicated that higher levels of risk appraisal (primary appraisal) and stronger coping evaluations (secondary appraisal) translated into greater preparedness outcomes. Thus, the theory not only informed the conceptualization of the research questions but also provided the interpretive lens through which the statistical outputs were understood.

2 Methodology

2.1 Study Area

The Weija-Gbawe Municipality is located in the southwestern part of the Greater Accra Region. The Municipality occupies an area of approximately 502.31 km2 and falls within the geographic coordinates of Latitudes 5°47'30"N and 5°27'30"N and Longitudes 0°31'30"W and 0°16'30"W (Weija-Gbawe Municipal Assembly, 2020). In relative terms, the Municipality shares boundaries with Ga South Municipality to the

west, Ga Central Municipality to the north, and Ablekuma North Municipality to the northeast. Figure 1 presents the map of the study area.

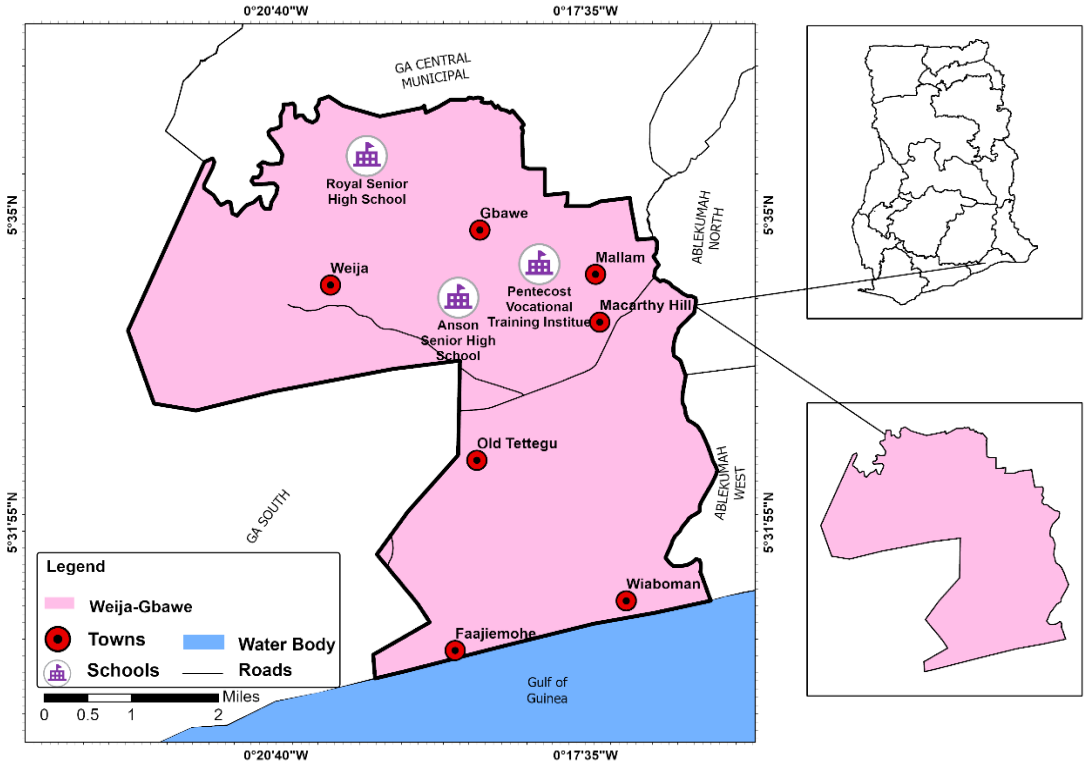

Figure 1: Map of the study area
Source: Authors construct (2022).

The Municipality also shares a boundary with Ablekuma West to the southeast and the Gulf of Guinea to the south. The Municipality has a population of 213,674 (Ghana Statistical Service, 2022). Weija-Gbawe Municipality is bounded by two major thrust faults: eastern and western fault. An observed fault on McCarthy Hills has been traced as far as Oblogo (Amponsah et al., 2020). The dominant geology of the Municipality is the biotite gneiss, quartzite minor mica schist and thickly bedded sandstones (Doku, 2013). The area is characterised by low ridges in several places ranging from 300 to 567 metres above mean sea level comprising mainly gneiss and granite to the west and sandstone, siltstone and shale to the east (Tagoe & Mantey, 2017).

2.2 Population size and Sampling

The study adopted a cross-sectional design with a population of all the two Senior High Schools (SHS) and one Vocational School (VS) in the Weija-Gbawe Municipality. The sample size formula n = N/1+ N (x)2, where n = sample size, N = Total Population, and x = margin of error of 0.05, helped find an estimated sample size of 219 respondents for the study. Ansong Senior High School (250), Pentecost Vocational Training Institute (PVTI) (120), Royals Senior High School (118) total 488. The sampled population was proportionately distributed among the school based on their student population. Therefore, the total sample for the study was 219. Following the

sample size was the sampling approach. The study adopted a multistage sampling. Proportional sampling was adopted to allocate the number of respondents each school should receive based on its percentage of the total population. A simple random sampling technique was further employed to select the individual student for the study. The demographic characteristics (Table 1) of respondents are presented below.

Table 1: Demographic Characteristics of Respondents

Variables	Frequency (n=219)	Percentage (%)
Gender		
Female	136	62.1
Male	83	37.9
Age		
15 – 19	119	54.3
20 – 25	100	45.7
Schools		
Ansong SHS	93	42.5
Pentecost VTI	52	23.7
Royals SHS	74	33.8
Form		
Form 2	91	41.6
Form 3	128	58.4
Ethnicity		
Akan	79	36.1
Ewe	62	28.3
Ga/Dagbme	46	21
Guan	13	5.9
Gruma/Bimo	2	0.9
Other	17	7.8
Religion		
Orthodox	43	19.6
Pentecostal/Charismatic	151	68.9
Traditionalist	2	0.9
Muslims	13	5.9
None	10	4.6
Area of Residence (Region)		
Greater Accra	173	79
Western North	4	1.8
Volta Region	10	4.6
Central Region	20	9.1
Eastern Region	6	2.7

Other Regions	6	2.7
Area of Residence (Town)		
Gbawe	100	45.7
Weija	38	17.4
Other places in Accra	51	23.3
Outside Greater Accra	30	13.7
Monthly stipend (GHS)		
10 – 100	64	29.2
110 – 200	48	21.9
210 – 300	42	19.2
310 – 400	16	7.3
410 – 500	22	10
510 +	27	12.3
Residence type		
Boarding	101	46.1
Day	67	30.6
Hostel	51	23.3

Key: p = < 0.05 =*, p= < 0.01=***
Source: Field Survey, 2021

2.3 Research Instrument and Data Collection Technique

The study adopted a close-ended questionnaire for the quantitative aspect of the work. The questionnaire comprises three (3) sections. The first section (A) gathered data on the demographic characteristics of the respondents. Section B gathered information on students' level of earthquake risk perception in Weija-Gbawe Municipality. The adapted scale was from the Disaster Risk Perception of University Students developed by (Mizrak & Aslan, 2020). The responses to the questions were on a 5-point Likert scale type with 1-Strongly disagree (SD), 2- Disagree (D), 3-Uncertain (U), 4- Agree (A) and 5-Strongly Agree (SA). Section C gathered information on the effect of earthquake risk perception on Senior High School students' metacognition. This section contains a 5-point Likert scale type with Poor (P) – 1, Fair (F) – 2, Average (A) – 3, Good (G) – 4, and Very Good (VG) – 5 to choose from. The scale was adapted from the Mizan meta-memory and meta-concentration scale for students developed by (Manzar et al., 2018).

To ensure the cultural and developmental appropriateness of the research instrument for Ghanaian Senior High School students, a multi-step contextualization process was undertaken. This required modification for linguistic, educational, and socio-cultural fit. The initial item pool was reviewed by three subject experts two psychologists with expertise in adolescent cognition and one disaster education specialist to assess relevance, clarity, and cultural alignment. Items were reworded into simpler, age-appropriate English to match the average reading level of SHS students in Ghana. Ambiguous or technical phrases were replaced with student-friendly expressions. Earthquake-related examples were localized to the Weija-

Gbawe municipality, referencing nearby tremors, and NADMO public education efforts to make risk scenarios relatable. The adapted scale was standardized, and psychometrically validated scales without a pre-test or pilot study. This reduces the need for additional pilot testing and ensures robustness for diverse research contexts. The instruments undergo rigorous construct validation, internal consistency testing, and cross-cultural assessment, allowing researchers to rely on their established psychometric properties without duplicating preliminary validation steps. The study adopted an electronic mode of data collection with the aid of KoboCollect/Toolbox. The researcher used a mobile phone to collect the data himself, which helped prevent missing information since all questions were answered by the respondents. The use of KoboCollect/Toolbox was also more time-efficient (Nampa et al., 2020).

2.4 Data Processing

The study employed exploratory (EFA) and confirmatory factor analysis (CFA) for testing the reliability of students' risk perception (Appendix 1) and metacognition (Appendix 2) scale. The study adopted principal component analysis (PCA). The orthogonal varimax rotation method was adopted to ensure the integrity and consistency of the scale. Factors with an eigenvalue greater than one were accepted. Factors loading criteria was set to 0.5. In contrast, items with less than 0.5 commonality were excluded from the scale since their inclusion can affect the results. Also, the internal consistency and Composite reliability were detested using the HTM master validity and reliability test in Amos 25.

The CFA run for students' risk perception produced a four-factor model (Appendix 5). with its model fit indices; CMIN/DF = 2.503, GFI = 0.882 CFI = 0.951, RMSEA = 0.043. The convergent validity was acceptable as the AVE was greater than 0.50 (Harun & Ahmad, 2016). The discriminant validity was achieved with MSV ranging from (0.43 - 0.66) which was less than AVE, which ranged from (0.60 - 0.87) (Engellant et al., 2016). Furthermore, maximum reliability MaxR (H) values were > 0.7. indicating a good model fit (Gaskin & Lim, 2016). All the hypothetical variables, exposure, anxiety, effects and uncontrollable, loaded three factors each, all the items in EFA also loaded significantly in the CFA. The validity analysis on students' level of earthquake risk perception scale composite reliability (CR) and average variance extraction (AVE) for all the latent variables meeting the minimum criteria for a good model fit (Jain & Chetty, 2021) (Appendix 6).

A confirmatory factor analysis run on students' metacognition scale produced a two-factor model (Appendix 7) with model fit indices; CMIN/DF = 2.001, GFI = 0.892, CFI = 0.934 and RMSEA = 0.073. The hypothetical variable meta-concentration loaded onto four items. All the items in EFA loaded significantly in the CFA as well. The Composite Reliability (CR) and Average Variance Extraction (AVE) for all the latent variables met a minimum criterion for a good model fit (Jain, 2021). The convergent validity was acceptable since the AVE is greater or equal to 0.50). While the discriminant validity was achieved since the MSV (.43-.66) was less than the AVE (.60-

.87). Also, Maximum Reliability MaxR (H) values were > 0.7, indicating a good model fit (Appendix 8).

2.5 Data Analysis and Ethical consideration

The analysis performed was descriptive, using the Kruskal-Wallis test and path analysis for socio-demographic characteristics of respondents (age, school, and form or class or level of students). All methods employed in this study were carried out in accordance with the appropriate rules.

To determine whether earthquake risk perception and metacognitive awareness differ significantly across groups (school, class level, and age categories), the Kruskal–Wallis H test was employed. This non-parametric test was chosen due to the ordinal nature of the data and the non-normal distribution of several variables, making it an appropriate alternative to ANOVA. Pairwise post-hoc comparisons were conducted. Results were reported with H-statistics and p-values. Only significant findings were interpreted in terms of direction and educational relevance, especially in relation to student group characteristics. Path analysis was conducted using Structural Equation Modeling (SEM) techniques for observed variables only (no latent constructs). Standardized regression coefficients (β) were computed to assess the strength and direction of relationships. Model diagnostics and fit indices (chi-square, CFI, RMSEA) were reported. Significance threshold set at $p < .05$.

Access to students, informed consent, anonymity, and confidentiality were all properly upheld in this study in terms of ethical considerations. All ethical guidelines for conducting the research were strictly followed. Here, experimental protocols were obtained from the Municipal Education Directorate and the headmasters of the selected schools. Additionally, the University of Education (UEW) Ethical Review Board reviewed and approved by the questionnaires as they considered it apt for data collection. The population's consent was sought, and they agreed to participate in the study At all times, respondents assented to the written informed consent form provided to them by signing the form after thoroughly reading and comprehending what the study sought to find. Since some of the respondents were less than 18 years of age, parental consent was duly sought before engaging those students in the study.

3 Results

3.1 Students' Level of Earthquake Risk Perception in Weija-Gbawe Municipality

The results show that perceived uncontrollability recorded the highest mean (M = 3.94, SD = 0.81), suggesting that respondents strongly believe that earthquakes are beyond human control (Table 2). This was closely followed by anxiety, which had a high average score (M = 3.87, SD = 0.83), indicating that many participants experience considerable emotional discomfort when thinking about potential seismic events (Table 2).

Table 2: Risk Perception Variables

Variables	M	SD	Skewness	Kurtosis
Effects	1.741	0.69	0.6111	0.721
Anxiety	1.880	0.74	0.443	0.262
Exposure	1.810	0.75	0.642	0.341
Uncontrollable	1.881	0.853	0.892	0.951

Source: Field Survey, 2021

In terms of perceived effects (M = 3.78, SD = 0.85), respondents largely agreed that an earthquake would have severe consequences (Table 2). Meanwhile, perceived exposure had a slightly lower mean (M = 3.51, SD = 0.89), reflecting moderate-to-high concern about the likelihood of experiencing an earthquake personally (Table 2).

This section looks at the level of students' earthquake risk perception in the Weija-Gbawe Municipality. The study adopted the Kruskal-Wallis sample test (h samples) to test significant variations between the levels of students' earthquake risk perception, exposure, anxiety, effects, and uncontrollable (Table 3) and demographic characteristics. The results revealed a statistical significance difference between age and effects of earthquake H (2) = 4.481, P < 0.00. The results further indicated a significant difference between age and anxiety H (2) = 1.801, P < 0.01. Also, there was a significant difference between age and exposure H (2) = 1.501 P < 0.02, and again there was a significant difference between age and uncontrollable H (2) = 6.402, P < 0.00 (Table 2).

Table 3: Kruskal Wallis test between Students' Earthquake Risk Perception and Demographic Characteristics

	Effects		Anxiety		Exposure		Uncontrollable	
Variable	H	P	H	p	H	p	H	p
School	3.302	0.000	32.782	0.000	18.000	0.001	33.401	0.002
Gender	0.942	0.330	1.181	0.280	2.100	0.153	0.502	0.003
Age	4.481	0.001	1.801	0.012	1.501	0.020	6.402	0.002
Form	6.441	0.001	2.900	0.052	3.011	0.04`	6.701	0.001
Religion	3.641	0.450	0.641	0.951	0.532	0.972	1.732	0.782
Ethnicity	3.040	0.691	3.3011	0.652	1.060	0.953	1.931	0.853
Region	3.682	0.590	5.851	0.320	5.021	0.412	3.591	0.692
Town	5.870	0.121	6.56	0.081	3.492	0.321	6.043	0.110
Monthly stipend	3.201	0.660	1.130	0.951	0.511	0.991	2.872	0.722
Residency type	1.112	0.781	0.760	0.860	0.300	0.962	0.541	0.912

Key; *H* = ≤ 1.00, p = 0.00

Source: Field Survey, 2021

Per schools, a significant difference was observed between school and effects H (2) = 34.302, P < 0.00. Also, a significant difference was observed between schools and anxiety H (2) = 32.782, P < 0.00. The results further indicated a significant difference between schools and exposure H (2) = 18.000, P < 0.00 and as well as schools and uncontrollable H (2) = 33.401, p < 0.00 (Table 3).

Per form, the Kruskal-Wallis K test demonstrated a significant difference between forms and effects H (2) = 6.441, P < 0.00. A significant difference was found between form and anxiety H (2) = 2.900 P < 0.05 whilst a statistical significance was again found between form and exposure H (2) = 3.011 P < 0.04 (Table 3). The results further demonstrated a statistical significance between form and uncontrollable H (2) = 6.701, P < 0.00 (Table 3).

Table 4: Kruskal-Wallis Post Hoc Pairwise Comparisons

Pairwise Comparison	Mean Rank	p-value	Significance
Ansong SHS vs Royals SHS	81.35 vs 138.38	< 0.001	***
Pentecost VTI vs Ansong SHS	99.74 vs 138.38	< 0.001	***
Royals SHS vs Pentecost VTI	81.35 vs 99.74	0.087	NS

Note: ***p < 0.001; NS = Not Significant

Source: Field Survey, 2021

A posthoc test showed that Ansong and Royals were statistically different from each other (M 81.35, 138. =38, P < 0.00) in terms of effects and exposure to earthquakes (Table 4) The results showed a statistical significance for Pentecost and Ansong (M = 99.74, 138.38, P < 0.00) in terms of the effects and anxiety of earthquake (Table 4) However, the post hoc test did not show any statistical significance between Royals and Pentecost (M = 81.35, 99.74, P < 0.00) in terms of exposure and uncontrollable an earthquake (Table 4)

The level of earthquake risk perception of students was analysed per their schools. Risk dimensions (exposure, anxiety, effects, and uncontrollable). The results showed that risk dimensions, uncontrollable (β = 0.51, p = 0.05) and exposure (β = 0.530, p = 0.02) significantly affected Royal SHS students' meta-concentration (Table 5) while anxiety (β = 0.441, p = 0.03) affected Royal SHS students' meta-memory (Table 5).

Table 5: Level of Disaster Risk Perception of Schools

			Ansong	Pentecost	Royal	Composite
Interactions			β	β	β	β
Meta-Concentration	<-	Effects	-0.432	-0.322	-0.742	0.183
Meta-Concentration	<-	Uncontrollable	0.133	0.124	0.541***	-0.212
Meta-Concentration	<-	Anxiety	-0.272	-0.391	-0.292	0.050
Meta-Concentration	<-	Exposure	0.323	0.271	0.530***	-0.370
Meta-memory	<-	Effects	-0.031	-0.132	-0.090	0.021
Meta-memory	<-	Anxiety	-0.032	-0.0522	0.441*	0.022
Meta-memory	<-	Exposure	0.001	0.451*	0.012	0.012
Meta-memory	<-	Uncontrollable	-0.011	-0.061	0.012	-0.093

Meta-memory	<-	Meta-concentration	0.63***	0.631***	0.632***	0.611***
CMIN/DF			1.322	1.343	2.432	3.243
GFI			0.951	1.002	0.982	0.902
CFI			1.001	0.901	0.961	1.002
RMSEA			0.652	0.671	0.592	0.603

Key: p = < 0.05 =*, p = < 0.01=***
Source: Field Survey, 2021

Furthermore, the results showed that exposure (β = 0.451, *p* = 0.04) significantly affected Pentecost VTI students' meta-memory (Table 5).

3.2 Level of disaster risk perception of students' metacognition per age group

For the age groups, the results indicated that exposure (β= 0.421, p = 0.05) significantly affected the meta-concentration of students within the age group 15–19 years (Table 6). Again, exposure (β= 0.541, p = 0.02) significantly affected 20–25 years of age group meta-concentration (Table 6), and also exposure (β= 0.513, p = 0.05) significantly affected the composite of age groups meta-concentration (Table 5).

Table 6: Level of Disaster Risk Perception per age groups

			Age 15 -19	Age 20-25	Composite (All age groups)
Interactions			B	β	β
Meta-concentration	<--	Effects	-0.642	-0.050	-0.370
Meta-concentration	<--	Uncontrollable	0.211	-0.150	0.051
Meta-concentration	<--	Anxiety	-0.051	-0.380	-0.212
Meta-concentration	<--	Exposure	0.421*	0.541*	0.513*
Meta-memory	<--	Exposure	-0.032	0.052	0.022
Meta-memory	<--	Effects	-0.173	-0.023	-0.091
Meta-memory	<--	Uncontrollable	0.012	-0.012	0.012
Meta-memory	<--	Anxiety	0.451*	-0.042	0.023
Meta-memory	<--	Meat-concentration	0.580***	0.64***	0.611***
CMIN/DF			3.452	4.362	5.302
GFI			0.9511	0.890	0.981
CFI			0.98	0.960	1.001
RMSEA			0.523	0.513	0.602

Key: p = < 0.05 =*, p= < 0.01=***
Source: Field Survey, 2021

Also, per the results further indicate that anxiety (β= 0.451, p = 0.03) significantly affected the 15–19-year age group's meta-memory (Table 6). Consistent with the quantitative data, data from open ended questions revealed that among all the age groups and their composite, exposure to earthquake hazard impedes their meta-concentration. At the same time, anxiety affects the 15–19-year age group's meta-memory but not in a way that thwarts their daily class activities.

3.3 Level of disaster risk perception of students' metacognition perform

The study assessed the level of earthquake risk perception among students in all three schools. The analysis showed a good model fit index (Table 7) per students' risk perception of metacognition (Gaskin & Lim, 2016). The results of the analysis perform showed that exposure (β= 0.530, p = 0.03) and uncontrollable (β= 0.532, p = 0.03) significantly affected all form two students' meta-cognition (Table 7).

Table 7: Level of Disaster Risk Perception per Forms

			Form 2	Form 3	Composite
Interactions			Estimate	Estimate	Estimate
Meta-Concentration	<--	Effects	-0.741	-0.203	-0.201
Meta-Concentration	<--	Uncontrollable	0.532*	-0.102	0.052
Meta-Concentration	<--	Anxiety	-0.291	-0.201	-0.403
Meta-Concentration	<--	Exposure	0.530*	0.041	0.183
Meta-memory	<--	Effects	-0.091	-0.102	-0.101
Meta-memory	<--	Uncontrollable	0.042	-0.011	0.013
Meta-memory	<--	Anxiety	0.431*	0.461*	0.023
Meta-memory	<--	Exposure	0.012	0.023	0.021
Meta-memory	<--	Meta-concentration	0.630***	0.591***	0.610***
CMIN/DF			3.242	2.432	1.432
GFI			0.891	1.001	0.841
CFI			0.891	0.980	1.002
RMSEA			0.560	0.561	0.591

Key: p = < 0.05 =*, p = < 0.01=***
Source: Field Survey, 2021

The study further showed that anxiety (β= 0.431, p = 0.02) statistically affected the meta-memory of Form two students among all the schools (Table 7). Anxiety (β= 0.461, p = 0.05) again significantly affected Form three students' meta-memory (Table 7).

3.4 Composite analysis of the effect of earthquake risk perception on students' metacognition

The composite analysis of students' perceptions of earthquake risk and metacognition is presented in this section. Meta-concentration and meta-memory served as the dependent variables. Exposure, anxiety, impacts, and uncontrollable independent variables are the four dimensions of risk. The results indicate that only exposure (β = 0.320, p = 0.03) significantly affected students' meta-memory (Table 8).

Table 8: Earthquake Risk Perception on Students' Meta-memory and Meta-concentration

Interactions		Risk Factors	β
Meta-Concentration	<---	Effects	-0.370
Meta-Concentration	<---	Uncontrollable	0.051
Meta-Concentration	<---	Anxiety	-0.213
Meta-Concentration	<---	Exposure	0.182
Meta-memory	<---	Effects	-0.091
Meta-memory	<---	Uncontrollable	0.013
Meta-memory	<---	Anxiety	0.021
Meta-memory	<---	Exposure	0.320*
CMIN/DF			1.412
GFI			0.981
CFI			0.990
RMSEA			0.561

Key: p = < 0.05 =*, p = < 0.01=***
Source: Field Survey, 2021

4 Discussion

For school, the findings of this study suggest that earthquake risk perception of students does not affect students' meta-concentration and meta-memory in general. However, some risk dimensions were found to have a statistically significant effect on students' meta-memory and meta-concentration. Uncontrollable exposure significantly affected Royal SHS students' meta-concentration. This conforms with Peng et al. (2017), who revealed that when students think that hazards are uncontrollable, they get scared, and their thoughts about possible disaster occurrence increase. It implies that students thinking about earthquakes in uncontrolled situations could have their concentration interrupted by earthquakes. This could be because of anxiety disorders such as fear, which in some cases are not directly associated with an experience of the hazard (Gerstner et al., 2020).

For the age groups, the results indicated that exposure significantly affects the meta-concentration of all the age groups and the composite of age groups. This conforms with Wang et al. (2021). They revealed that the difference in exposure among people to a hazard affects metacognitive beliefs variables. This implies that students' exposure to and awareness of earthquakes affected their meta-concentration. This could be that students think about earthquake occurrences in their environment at least once in a while, which could distort their attention in class.

By the form, the analysis results demonstrated that exposure, uncontrollability, and anxiety significantly affected two students' meta-memory. Similar to other studies, meta-memory is found to be affected by risk perception (Lanciano et al., 2020). Though earthquake risk perception does not impede students' meta-memory, once in a while some students think, once in a while some students believe, and once in a while some students feel about it, and this may affect their meta-memory. Data from open ended questions revealed that, some students become anxious when they feel a shake in their school buildings, which reminds them of a previous earth tremor. This has the potential to distort their concentration in class.

The mixed results demonstrated that only exposure significantly affects the composite of all students' meta-memory. The results indicate that uncontrollable anxiety and exposure effects do not statistically affect students' meta-concentration. Also, uncontrollable effects and stress do not significantly affect students' meta-memory (Rhodes, 2019). This could be attributed to the low awareness of students. There was no significant difference in the earthquake awareness of undergraduate students' earthquake awareness levels according to their residences (Sözen, 2019). Planning to prepare for risk is a cognitive and affective function of the brain that is influenced by individual perception. Students' meta-concentration and meta-memory were unaffected by the occurrence of earthquakes/earth tremors in their areas of residence or school locations. This could be inferred based on the theory that for students to concentrate during class activities is also a function of the cognitive part of the brain. Still, in this study, students' meta-memory was not entirely affected by their meta-memory.

The results of the post hoc test suggest that institutional context, including factors like risk education exposure and psychosocial framing of disasters, may influence how students perceive seismic threats. For instance, Pentecost Vocational Institute is affiliated with religious organizations, which may actively integrate disaster awareness with spiritual teachings, potentially affecting students’ emotional or moral appraisal of earthquakes. The lower risk perception among Ansong SHS students points to gaps in risk communication or lower frequency of disaster-related activities and drills in the school. The availability of school-based risk education and teachers’ attitudes towards disaster topics can significantly shape students’ cognitive and emotional responses (Yildiz et al., 2020; Harun & Ahmad, 2016).

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school. The availability of school-based risk education and teachers' attitudes towards disaster topics can significantly shape students' cognitive and emotional responses (Yildiz et al., 2020; Harun & Ahmad, 2016). Despite students showing high-rated risk, uncontrollability showed no significant effect on meta-memory in the composite model. This contradicts Peng et al. (2017) and Gerber et al. (2019), who argue uncontrollable risk impairs cognitive function.

Variables related to perceived susceptibility and severity capture the essence of primary appraisal, while constructs such as coping efficacy and resource availability reflect secondary appraisal. These two levels of appraisal are linked to preparedness outcomes: primary appraisals were found to heighten awareness and motivate the recognition of risk, whereas secondary appraisals provided the confidence and practical orientation necessary for translating concern into action. By integrating both appraisal levels, the findings reinforce CAT's proposition that disaster preparedness is not only about perceiving risk but also about evaluating one's ability to manage it effectively.

The study's findings were in line with the Cognitive Appraisal Theory, as students who perceive high risk and low coping capacity, like exposure, showed impaired meta-concentration. While students with moderate or low risk perception maintained stable metacognition. This confirms the primary (threat) and secondary (control) appraisal pathways from the theory. Also, Metacognitive theory by Flavell aligns with study findings, as the study showed disruption in attention (meta-concentration) and recall (meta-memory) from perceived threat, confirming that emotional states impair their ability to regulate thought. The theory assumes that all cognitive control is vulnerable under stress; however, findings showed some students (Form 3 students or Pentecost VTI students) maintained cognitive performance despite high perceived risk. This could result in some students benefiting from disaster education, personal maturity, or coping strategies.

5 Conclusion

There have been numerous reports of earth tremors in Weija-Gbawe Municipality, and this has a propensity to influence students' perceptions of when an earthquake would occur. Pondering on the occurrence of an earthquake can impair their meta-memory and meta-cognition abilities, which calls for attention. The study concludes that senior high school students in Weija-Gbawe have high risk perception. Risk perception dimensions like anxiety, uncontrollability, and exposure significantly affect students' metacognitive abilities. Senior high school students' risk perception of the destructive nature of earthquakes is low. This highlights the importance of metacognitive skill training in disaster education programs for senior high school students in Weija-Gbawe Municipality. NADMO and GES can collaborate to organize school earthquake resilience programs tailored for senior high school students. This should include a workshop on how to control anxiety. Training for teachers and guidance and counselling units to assist students with metacognitive needs, especially those whose metacognition has been affected by anxiety and exposure.

Through the National Disaster Management Organisation (NADMO), the government should develop an earthquake disaster plan for schools within Weija-Gbawe Municipality and beyond. Students' metacognition is monitored after their level of attention has been raised in order-memory and after their level of understanding has been extended to prevent any future psychological disorders. This study links earthquake risk perception with metacognitive functioning among African senior high school students, a unique contribution to literature as a novel study of its kind in Africa to examine cognitive dimensions. The study highlights the psychological impacts of earthquake-prone areas, emphasizing the need for metacognitive skill training in disaster education programs in Ghanaian schools. The study's limitations include a cross-sectional design, self-reported data, lack of qualitative triangulation, cultural validity, and academic performance data, which hinders causal relationships between risk perception and metacognitive functioning.

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Appendix 1

Factor Analysis on Students' Level of Earthquake Risk

Item	Components				Communalities
	1	2	3	4	
Exposure					
I am likely to experience earthquake disaster on campus before I graduate	0.84				0.76
Disaster poses a great threat to campus	0.83				0.81
It is likely I could be harmed in disaster on campus	0.68				0.67
Anxiety					
Earthquake makes me worry when I am on campus		0.88			0.83
Disaster makes me dread when I am on campus		0.87			0.89
When I think of earthquake disasters, I get depressed		0.75			0.82
Effect					
I think earthquake possess financial damage on campus			0.79		0.91
When earthquake occurs school will stop for a long time			0.83		0.93
I have constant feelings that earthquake will happen to me on campus			0.84		0.94
Uncontrollable					
When earthquake happens on campus, I cannot protect myself				0.88	0.92
Disaster plans cannot be successfully be implemented during earthquake				0.89	0.94
I do not trust school management about disaster				0.88	0.86
Total Eigenvalues	6.28	1.42	0.98	0.68	
% of Variance	57.06	12.93	8.94	6.15	
Cumulative %	57.06	69.99	78.9	85.08	

Source: Field Survey, 2021
Key: p = < 0.05 =*, p= < 0.01=***

Appendix 2

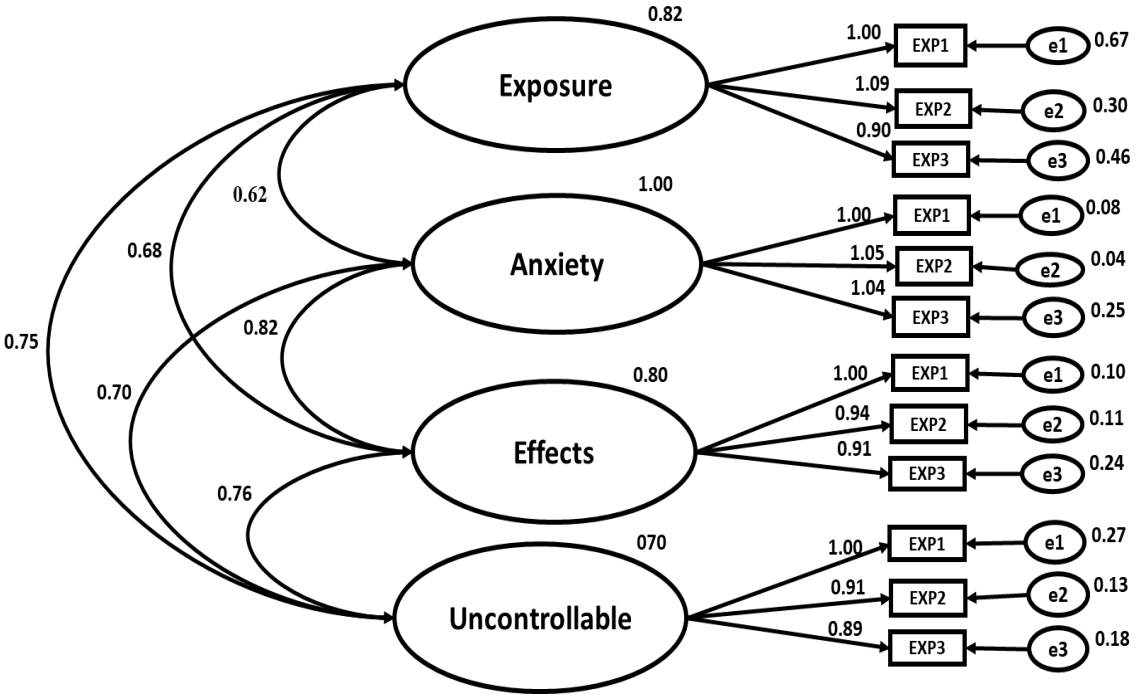
Factor Analysis of Effects of Earthquake Risk perception on Students' Metacognition

Item	Component		Communalities
	1	2	
Meta-Concentration			
I am able to understand all concepts taught from the start to end during the class and practical attachments	0.85		0.84
I am good at concentrating during lessons, workshops and practical attachments	0.83		0.78
I have no trouble in keeping concentration during conversations with my teachers and friends	0.81		0.72
I am good at concentrating when reading subject textbook and listening to teachers in class	0.70		0.75
Meta-Memory			
I am good at remembering conversation I had with my teachers and friends		0.86	0.84
I am good at remembering the content of lessons and reproduce it well during exams and assessments		0.82	0.83
I have no trouble remembering where I have put my handouts and textbooks		0.56	0.82
Total Eigenvalues	5.226	682	
% of Variance	65.33	8.53	
Cumulative %	65.33	73.85	

Source: Field Survey, 2021
Key: p = < 0.05 =*, p= < 0.01=***

Appendix 3

Students' Level of Earthquake Risk perception



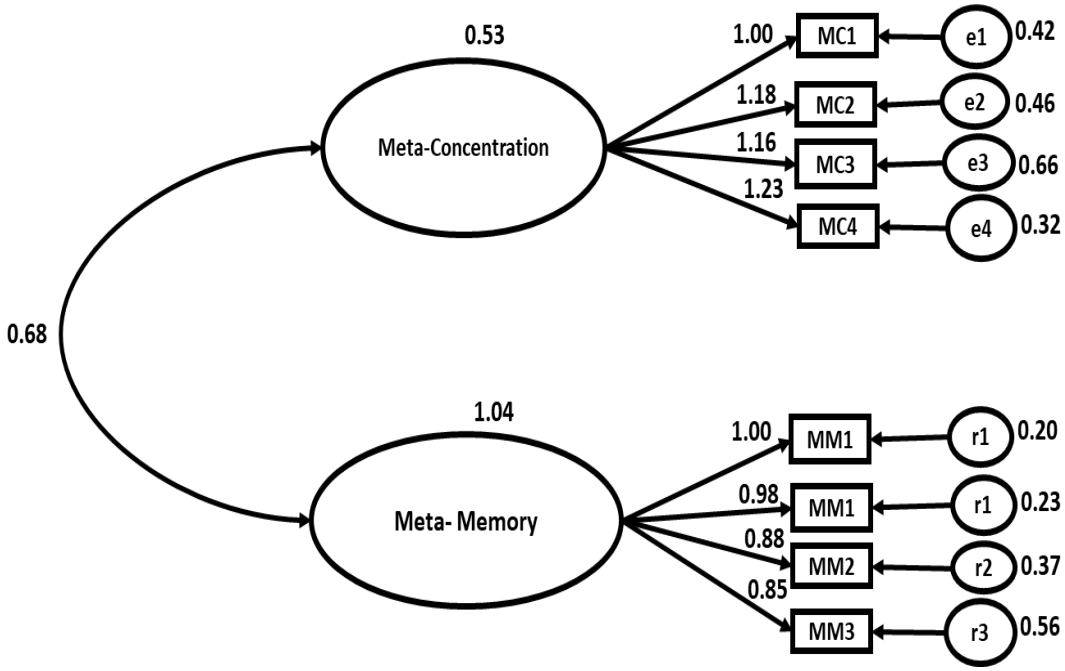
Appendix 4

Validity on Students' Level of Earthquake Risk Perception

Latent Variable	CR	AVE	MSV	MaxR (H)	Exposure	Anxiety	Effects	Uncontrollable
Exposure	0.82	0.60	0.43	0.84	0.77			
Anxiety	0.90	0.75	0.52	0.91	0.65***	0.86		
Effects	0.88	0.79	0.66	0.90	0.59***	0.72***	0.88	
Uncontrollable	0.95	0.87	0.66	0.97	0.50***	0.59***	0.81***	0.93

Appendix 5

Effects of Earthquake Risk perception on Students' Metacognition.



Appendix 6

Validity on the Effect of Earthquake Risk Perception on Students' Metacognition

Hypothetical variable	CR	AVE	MSV	MaxR(H)	Meta-Concentration	Meta-Memory
Meta-Concentration	0.92	0.74	0.51	0.94	0.9	
Meta-Memory	0.86	0.61	0.51	0.88	0.898***	0.779