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College students' perceived teaching presence in emergency remote online mathematics teaching

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ABSTRACT

In this period of the Covid-19 outbreak, the interest in replacing conventional face-to-face teaching with online teaching in Ghana's Colleges of Education has sown amidst concerns about the presence of teaching. Through an online survey, 452 students from three education colleges responded to the teaching presence scale. This study examined college students' perception of mathematics teaching presence and how gender and the mode of interaction affected students' sense of teaching presence during the emergency remote online teaching of mathematics. The results showed that about 82.7% of the students had a moderate to a high sense of mathematics teaching presence in the emergency remote online teaching. This means that mathematics teachers were unable to identify the mathematics learning needs, neither were teachers able to manage collaborative and reflective work, nor averted undirected discourse among 27.3% of the students. Although the gender of students did not affect the sense of mathematics teaching, the result indicated that in the absence of asynchronous mode of interaction, synchronous and blended modes of interaction positively affected students' perceived mathematics teaching presence. Altogether, this study urges mathematics teachers to employ creative pedagogical approaches that make teaching presence more conspicuous to students in emergency remote online mathematics teaching.

INTRODUCTION

At the core of mathematics teaching is the provision of learning support to learners. This support may involve extra and optional assistive activities such as one-on-one assistance, designated space for support, or remedial programs for developing students' mathematics confidence and skills (MacGillivray, 2008). In teaching mathematics as it is with other school subjects, the learning support provided by teachers seeks to promote collaborative learning, students' active participation and instructor-guided inquiry (Rovai, 2002). Consequently, the capacity of teachers to effectively promote collaborative learning, students' active participation and instructor-guided inquiry that make students mentally and emotionally connected to teaching within an instructional period make learners feel the presence of teaching (Shea et al., 2006).

Therefore, the provision of learning support becomes a function of mathematics teaching presence irrespective of the platform for teaching – face-to-face, online or a blend of both face-to-face and online. Studies by Jaggars (2014) and Seaton et al. (2014) show that mathematics

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instruction delivered through face-to-face supports one-on-one peer and teacher discourse, planned and spontaneous group discussions, and board illustrations. By extension, there is evidence of mathematics teaching presence in face-to-face instructional set-ups. Similarly, teaching presence in online mathematics teaching is not in doubt. As explained by Picciano (2002), presence ensures that although physical contact is not possible in online instruction, students have the sense of being in and belonging in a course and have the ability to interact with other students and the instructor.

Empirically, Holt (2020) applied a phenomenological study to explore teaching presence in an online mathematics course. In the study, Holt (2020) found that mathematics teachers used assessments with automatic feedback during online teaching, established due dates and flow of the course, monitored student participation, and ensured frequent and precise communication to demonstrate teaching presence. Additionally, Holt (2020) observed indicators of teaching presence such as teachers' delivery of course content, engagement of students with questions and answers, and the availability of course materials. Other studies (Hegeman, 2015; Tran & Nguyen, 2021; Wang & Stein, 2021) have also showed that online mathematics teaching promotes teaching presence. Arguably, the physical absence of mathematics teachers during online teaching does not preclude them from making their mathematics teaching presence conspicuous (Zhang et al., 2016).

Although teaching presence influences students' success in online mathematics learning, educational experiences and learning outcomes (Hegeman, 2015; Shea et al., 2006; Wang & Stein, 2021), there is a concern that teaching presence may be a more difficult task to realize in online teaching (Garrison, 2017; Jaggars, 2014), especially with mathematics courses. This perceived difficulty might partly be because students feel that complex subjects such as mathematics should be taught in a face-to-face learning environment where weaker teaching presence and weaker student-student interactions are averted (Jaggars, 2014) or partly due to contextual factors (Caskurlu et al., 2020; Epp et al., 2017) and the mode of interaction (Garrison, 2017; Ogbonna et al., 2019). For example, Phelps and Howell (2016) contend that contextual factors such as gender, age, teaching approaches, socio-economic status, among others, can influence significant aspects of mathematics instruction. Accordingly, at least two objectives may be achieved by examining the presence of teaching in an emergency remote online teaching and learning of mathematics among college students who were compelled to take online courses due to the outbreak of Covid-19. First is the awareness of the students' perceived level of teaching presence, and secondly, the knowledge of the extent to which context factors related to their perceived teaching presence.

Concerning gender as a context factor, Garland and Martin (2005) admonish researchers to recognize that gender can play a role in online learning, hence, the importance of considering the gender of students in the development and design of courses and programs. Although gender should not have been a priority given that both male and female student have equal access to, and engagement in online teaching, it has become a focal point because of the perceived disparity in the performance of male and female students in mathematics (Little-Wiles et al., 2014). Besides, there is documentation of mixed findings about how male and female students perceive teaching presence in online teaching. For example, while Laves (2010) and Almasi et al. (2018) could not establish a significant relationship between students' perception of teaching presence and their genders, Garrison et al. (2010) point out the possibility of a relationship between gender and teaching presence.

Regarding the modes of online interaction, synchronous, asynchronous or a blend of the synchronous and asynchronous can be utilized in online teaching (Hodges et al., 2020; Ogbonna et al., 2019). However, irrespective of the mode of online interaction, Garrison (2017) admonishes that a blend of synchronous and asynchronous modes of interaction in online teaching generally gives the impression of immediacy, which can be very effective in establishing a presence. Nevertheless, Weissman (2017) suggest that synchronous mode of interaction promotes teaching presence better than asynchronous mode of interaction. This is because synchronous interaction provides a live alternative to interacting with a course's content. It also allows for open and unstructured dialog, thus, reducing the amount of time spent on it. Furthermore, it aids in breaking down a sense of isolation, encouraging and assisting in collaborative practice and interaction, and increasing personal and cognitive participation. Asynchronous modes of interaction on the other hand according to

Goralski and Falk (2017) restrain students from learning independently or completing learning tasks in isolation.

Conceptualizing teaching presence

The community of inquiry is a framework that describes the overall educational experiences in an online learning environment. According to Garrison (2017) and Garrison and Akyol (2013), the community of inquiry framework explains educational experiences from three elements: social presence, cognitive presence and teaching presence. However, teaching presence identifies the needs of students and guides them to achieve the desired learning outcomes through the establishment of curriculum content, learning activities, timelines, monitoring, and managing collaborative and reflective work, (Garrison et al., 2010; Garrison & Akyol, 2013). Besides, teaching presence is seen as the fulcrum around which social and cognitive presences evolve (Garrison et al., 2010; Garrison & Akyol, 2013; Kyei-Blankson et al., 2019; Shea et al., 2006). Inferring from Rodgers and Raider-Roth (2006) and Garrison and Akyol (2013), the presence of mathematics teaching is the students' feeling of being connected mentally, emotionally and physically within the mathematics learning environment. Although teaching presence is identified with all participants in the teaching and learning encounter (Almasi et al., 2018; Garrison et al., 2001), the central actor in appreciating the presence of teaching is the instructor whose responsibility is to establish a purposeful and helpful inquiry community (Garrison & Akyol, 2013).

The theoretical framework guiding this study is Garrison et al. (2001) conceptualization of teaching presence. According to Garrison et al. (2001, p. 5), teaching presence refers to the instructor's "design, facilitation, and direction of cognitive and social processes to realize personally meaningful and educationally worthwhile learning outcomes". Based on the definition by Garrison et al. (2001), Garrison and Akyol (2013) outlined three interconnected elements of teaching presence – organization and design, direct instruction, and facilitation of discourse. These three elements are described by Shea et al. (2006) as follows:

1. The indicators that describe the component of course organization and design include the design of a comprehensive course outline based on the teaching curriculum and the efficient use and management of instructional time. The component also prompts students' adherence to a group and social norms and etiquette.
2. The direct instruction component in the conceptualization of teaching presence focuses on the depth of content and its presentation, questioning strategies, effective conclusion of instruction, handling students' misconceptions, errors and learning concerns.
3. The facilitation component emphasizes the learning processes, which lead to cognitive activation and concept formation. Such indicators include a learning setting in which students' contributions to the discussion are encouraged and critiqued to build consensus. It also relates to students' support that stimulates and sustains their learning quest.

Empirically, the realization of these three components of teaching presence has not always been evident. Previous studies have concluded on a varied number of components of teaching presence. For instance, both Laves (2010) and Shea et al. (2006) discovered two components – instructional design and organization, and directed facilitation in separate studies using different samples. However, Caskurlu (2018) confirmed the three elements of teaching presence. It is this varying conclusions that researchers (Caskurlu, 2018; Caskurlu et al., 2020) are calling for revisit of the theoretical conceptualization of teaching presence. Despite the theoretical compartmentalization of teaching presence, the three elements are interwoven to realize a worthwhile online mathematics learning experience for at least two reasons. In the first place, since interaction and discourse are significant for higher-order learning, they are unattainable without a workable design, facilitation and direction contrived by the instructor. Secondly, it is the mathematics instructor's guidance that averts undirected monologues and ensures fruitful mathematical discussions, providing cognitive activation and individual student or group support.

Emergency remote online mathematics teaching

In the wake of the Covid-19 pandemic, the government of Ghana in the year 2020 placed a nationwide ban on conventional face-to-face classroom instruction (Nyabor, 2020). As a result, conventional instructional activities in Colleges of Education (CoE) were replaced with an emergency remote (ER) online teaching. This ER online teaching was a temporal shift from the conventional face-to-face instructional delivery to online instruction with the anticipation of a reversal to the status quo once the Covid-19 pandemic was over (Agormedah et al., 2020). Taylor-Guy and Chase (2020) are of the view that with a well-structured and well-planned ER online teaching that uses appropriate learning systems, learning experiences equivalent to face-to-face learning experiences can be achieved with online teaching. Consequently, ER online teaching, as espoused by Liang et al. (2018), became an obvious alternative to the conventional classroom face-to-face teaching practices. Formal didactics in 2020 were therefore conducted online.

Teachers enacted the online instruction via learning management systems, google classroom and social media platforms such as What's App and Telegram. Prior to the implementation of the ER online teaching, CoE teachers received generic training on how to enact online instruction without recompensing for the online instructional needs of specific subjects like mathematics. Thus, mathematics teachers enacted the online instruction synchronously or asynchronously without any specialised training in online mathematics teaching even though mathematics teachers were expected to make their mathematics teaching present.

Suspiciously, instructional activities such as student-teacher interaction, communication, imitation and practice which define mathematics teaching presence may have been traded-off because mathematics teachers were either unable to use online learning tools to achieve these activities or the online learning systems did not support such activities. Coincidentally, Learning, Teaching and Applying Geometry and Handling Data was one of the mathematics courses taught by mathematics teachers during the ER online teaching. In this mathematics course (Ministry of Education, 2018), students were required to relate concepts from geometry to geometrical phenomenon; develop and consolidate basic mathematical knowledge and skills in the domain of geometry and handling data taking into account cross-cutting issues such as students' characteristics, misconceptions and difficulties in the domain of the course. Mathematics teachers were also expected to provide students with practical learning activities, real-life applications and sufficient practice time during the ER online teaching.

With the implementation of the online teaching in colleges of education and other tertiary institutions in Ghana, Agormedah et al. (2020) explored the enactment of online learning in higher education during the COVID-19 pandemic. It was observed that though some Ghanaian tertiary students were enthusiastic about online learning, they were not prepared for it. This is because students had no formal orientation, and they were challenged with intermittent internet connectivity (Agormedah et al., 2020). Unfortunately, Agormedah et al. (2020) study did not explore the teaching activities provided during the online teaching. Further search in existing studies showed literature is draught about college students' sense of mathematics teaching presence in the ER online teaching in Ghana. Therefore, this study sought to explore the perception of college students' sense of teaching presence and determine how gender and modes of interaction affected their sense of teaching presence in the ER online teaching of mathematics. The following research questions were addressed in detail by the study:

Research questions

Research question one (RQ1): What is students' perceived level of teaching presence in the ER online mathematics teaching?

Research question two (RQ2): To what extent does gender and mode of interaction affect students' sense of teaching presence in ER online mathematics teaching?

Gender in this study was operationalized to reflect the traditional description of sex (male or female). The modes of interaction were defined to include synchronous, asynchronous and blended. The synchronous mode of interaction occurred when the teacher and students' class interactions happened in real-time. The asynchronous interaction occurred through online channels without real-time interaction (that is, both teacher and students' activities on the learning platform did not co-occur). The blended interaction occurred when the synchronous and asynchronous were applied in the ER online mathematics teaching.

METHODS

Research design

A cross-sectional survey design was applied in this study. In this regard, an online survey to collect data on college students' perceptions of teaching in the ER online teaching of mathematics was administered. The online data collection was used because college students were not physically on campus. The data collected included college students' perception about teaching presence in the ER online mathematics teaching, their gender and their preferred mode of interaction.

Instrumentation

The 13-item teaching presence scale (TPS) (Arbaugh et al., 2008) was adopted to examine college students' perception of teaching presence in the ER online mathematics teaching. The 13-item TPS is a 4-point Likert scale with responses ranging from a minimum of 1 (strongly disagree) to a maximum of 4 (strongly agree). The 13-item teaching presence questionnaire unraveled students' perception about teachers' organization and design, direct instruction, and facilitation of discourse. For example, the items '*the tutor clearly communicated important course goals*' and '*the tutor provided clear instructions on how to participate in course learning activities*' bothered on organization and design. For direct instruction, the statement '*the tutor helped to focus discussion on relevant issues in a way that helped me to learn*' was posed. On the facilitation of discourse, the statements included '*the tutor encouraged course mates to explore new concepts in this course*', '*the tutor helped keep course mates on task in a way that helped me to learn*' and '*the tutor was helpful in identifying areas of agreement and disagreement on course topics that helped me to learn*'. Previous studies have shown that the TPS is a reliable and suitable measure of teaching presence. The internal reliability for the scale was 0.95 (Yu & Richardson, 2015) and 0.96 (Caskurlu, 2018).

Data collection and analysis procedure

Responses to the TPS were received from the college students between the seventh and tenth weeks of the ER teaching. At the time of administering the questionnaire, college students had done more than half the 16-week semester. This lapse of teaching period gave students enough experience to appraise the presence of mathematics teaching in the ER online teaching. At the end of the tenth week, there were no new responses (entries); hence, the portal for receiving the entries was closed. Only online responses were received because students could not be contacted physically. As a result, it is possible that only students who were intrinsically motivated to share their online learning experience partook in the study. Permission to carry out this study was sought from the mathematics teachers who taught the students concerned. Besides, all ethical considerations including the right to or not to participate in the survey were adhered to.

The study's research questions formed the basis for the data analysis. Prior to answering the research questions, an exploratory factor analysis was conducted. Besides, the normality and reliability of the teaching presence scale was examined. Subsequently, the mean and standard deviations were used to examine students' perceived levels of teaching presence (RQ 1). Correlation and standard multiple regression analysis were used to explore how students' gender and mode of interaction affected their reported sense of teaching presence during the ER online teaching of mathematics (RQ 2).

Participants

The population for this study constituted all level 100 students of the 14 colleges affiliated with the university of education, Winneba. The multi-stage purposeful random sampling (Omona, 2013) was used to select respondents. At the first stage, the 14 colleges were stratified into three strata according to the gender composition of the colleges (that is, one single-sex male college, two single-sex female colleges, and 11 mixed-sex colleges). Using simple random sampling one college from these three strata was sampled. The three sampled colleges were identified as men's college, female's college and mixed college. In the last stage, 519 out of 1,297 level 100 college students (representing about 40% response rate) voluntarily answered the teaching presence scale. Out of the 519 data received, 67 were deleted because they were either non-engaging responses (22 responses) or outliers (45 responses). Therefore, 452 data sets (questionnaire responses) was used in subsequent analyses.

FINDINGS

Preliminary measures

Exploratory factor analysis (EFA) was conducted to obtain a parsimonious factor structure for the TPS. Principal Component Analysis (PCA) was used to ascertain the factorability of the TPS because according to Timm (2004) PCA is more tolerable to produce solutions even on data that violates normality. Based on literature (Hair et al., 2019), the Kaiser-Meyer-Olkin measure of sampling adequacy (.956) was excellent. Additionally, a significant Bartlett's Test of Sphericity (Chi-Square$=$ 4965.170, df$=$ 78, $p < .05$) was met. By using the oblique rotation method at Eigenvalues greater than 1, a single factor was extracted, which explained about 65% of variance in the data distribution. Further exploration with a Monte Carlo parallel analysis (Watkins, 2000) confirmed a single factor. Hence, the three components of the TPS (design and organization, facilitation of discourse, and direct instruction) (Garrison et al., 2010; Garrison & Akyol, 2013; Garrison et al., 2001) are implied in discussing the presence of teaching in the ER online teaching of mathematics.

Following the EFA, the reliability of the TPS was verified using Cronbach's alpha and item-rest correlation. Based on the suggestions provided in the literature (Field et al., 2012; Zijlmans et al., 2018) the Cronbach's alpha (∝=.954) and item-rest correlation (.524 ≤ item-rest r ≤ .870) for the 13-item TPS were high. The result suggested that the scale was reliable and the items were internally consistent. Hence, the TPS is a full scale for measuring the teaching presence experiences of college students of the three CoE in online mathematics instruction.

Subsequently, the univariate normality of the teaching presence data was tested. A visual inspection of the box plot, normal Q-Q plot and the calculated difference in the mean rating (2.74) and the 5% Trimmed mean (2.75) showed that the teaching presence data was relatively normally distributed. Besides, the largeness of the sample size was sufficient to avert any statistical complications (Tabachnick & Fidell, 2013). Above all, computed chi-square difference in sample sizes showed that the differences in all two categories (gender and modes of interaction) were statistically significant. That is, for gender, $\chi^2(1) = 60.965, p < .05$; and for interaction mode, $\chi^2(2) = 25.438, p < .05$. This result showed that the distribution of the data was statistically not evenly distributed.

Students' perceived level of teaching presence in the ER online mathematics teaching

In exploring the students' sense of teaching presence during the ER online mathematics teaching, the mean and standard deviation scores were used to answer RQ1. Based on the students' overall mean (M = 2.74) and standard deviation (SD = .56) statistics, students' perceived sense of mathematics teaching presence was categorized empirically into three levels (low, medium, high sense of teaching presence). Low mathematics teaching presence scores were at most one standard deviation below the overall sample mean. High mathematics teaching presence scores were at least one standard deviation above the overall sample mean, and medium mathematics teaching presence scores were within one standard deviation below and above the overall sample mean. The summary of the perceived levels of teaching presence is presented in Table 1.

From the gender point of view, the results showed that more than 80% of the male and female students experienced medium to high levels of teaching presence. However, among the male students, students experiencing low teaching presence were more than students experiencing high teaching presence (net difference = 22, representing 7.1%) and female students (net difference = 2, representing 1.4%). Besides, female students' sense of teaching presence ($M = 2.80, SD = .55$) was higher than the sense of teaching presence among male students ($M = 2.71, SD = .56$) in the ER online teaching of mathematics.

From the perspective of students' preferred mode of interaction, the results showed that more than 80% of students who preferred synchronous and blended interaction modes experienced medium to high levels of teaching presence. However, only 61.8% of students who preferred asynchronous modes experienced medium to high levels of teaching presence in the ER online teaching of mathematics. Interestingly, the results showed that the number of students who experienced low and high levels of teaching presence within the synchronous group was equal (N = 12, net difference = 0). Meanwhile, the number of students who experienced low levels of teaching

Tabel 1
Perceived levels of teaching presence

Levels	Overall TP		Female		Male		Synch		Asych		Blended	
	N	%	N	%	N	%	N	%	N	%	N	%
Low	78	17.3	20	14	58	18.8	12	8.3	42	38.2	24	12.2
Medium	320	70.8	105	73.4	215	69.6	121	83.4	58	52.7	141	71.6
High	54	11.9	18	12.6	36	11.7	12	8.3	10	9.1	32	16.2
Mean	2.74		2.80		2.71		2.82		2.42		2.85	
SD	.56		.55		.56		.46		.68		.48	
Total N	452		143		309		145		110		197	

Sync = synchronous; Async = asynchronous; N = students; TP = teaching presence

presence was more than those who experienced high levels of teaching presence within the asynchronous group (net difference = 32, representing 29.1%). Also, the number of students who experienced low levels of teaching presence was less than those who experienced high levels of teaching presence within the blended group (net difference = 8, representing 4%). More so, students who preferred the blended instructional modes experienced more of teaching presence ($M = 2.85, SD = .48$) than students who were taught with only asynchronous mode ($M = 2.42, SD = .68$) or synchronous modes only ($M = 2.82, SD = .46$). Likewise, students who preferred the synchronous modes only ($M = 2.82, SD = .46$) experienced teaching presence than students who preferred the asynchronous mode only ($M = 2.42, SD = .68$).

The overall distribution showed that more than 80% of the students experienced medium to high levels of teaching presence in mathematics. However, many more students experienced low teaching presence than high teaching presence (net difference = 24, representing 5.4%) during the ER online mathematics teaching. The results showed that most of the students (70.8%, N = 320) experienced medium levels of teaching presence. Again, the overall students' perceived teaching presence in the ER online teaching of mathematics ($M = 2.74, SD = .56$) was only higher than the teaching presence of male students ($M = 2.71, SD = .56$) and students' who were taught through only asynchronous mode of teaching ($M = 2.42, SD = .68$).

The effect of gender and mode of interaction on teaching presence

Correlation and standard multiple regression analysis were used to explore how students' gender and mode of interaction affected their reported sense of teaching presence during the ER online teaching of mathematics (RQ2). Consequently, gender (male and female) and mode of interaction (synchronous, asynchronous, and blended) were dummy coded. In discussing the extent to which teaching presence correlated with gender and modes of interaction, Cohen's (1988) benchmark: small ($r = .1$), moderate ($r = .3$) and large ($r = .5$) was applied. The computed Pearson-moment correlation results are presented in Table 2.

In Table 2, the correlation between students' gender and their reported teaching presence did not reach a significance level ($r = -.073, p > .05$, two-tailed). However, the correlation between the mode of interaction and teaching presence was statistically significant in negative and positive directions. For negative significant correlations, the correlation between asynchronous mode of interaction and teaching presence was moderately negative ($r = -.320, p < .01$, two-tailed) with the blended and synchronous modes set as references. This result revealed an inverse correlation between the asynchronous mode of interaction and the perceived presence of teaching in the ER online teaching of mathematics, which was .320 times lower than the mixed and synchronous modes of interaction.

For the positive correlations, the correlation between synchronous mode of interaction and teaching presence was small ($r = .106, p < .05$, two-tailed) and ($r = .177, p < .01$, two-tailed) with the blended and asynchronous modes set as references respectively. This result revealed that the direct correlation between the synchronous mode of interaction and the perceived presence of teaching in the ER online teaching of mathematics was .106 and .177 times higher than with the

Table 2

Correlation between reported sense of teaching presence with gender and mode of interaction

#	Variables	1	2	3	4
1	Teaching presence	1	-.073	.106*	-.320**
2	Male students [a]		1	-.134**	.208**
3	Synchronous mode [b]			1	-.390**
4	Asynchronous mode [b]				1
1	Teaching presence	1	-.073	-.320**	.177**
2	Male students [a]		1	.208**	-.054
3	Asynchronous mode [c]			1	-.498**
4	Blended mode [c]				1
1	Teaching presence	1	-.073	.177**	.106*
2	Male students [a]		1	-.054	-.134**
3	Synchronous mode [d]			1	-.604**
4	Blended mode [d]				1

**. P< 0.05; **. P< 0.01*

Referenced variables *(a = female; b = blended mode; c = synchronous; d = asynchronous).*

blended and synchronous modes of interaction respectively. Furthermore, the correlation between blended mode of interaction and teaching presence was small ($r = .177, p < .01$, two-tailed) and ($r = .106, p < .05$, two-tailed) with the synchronous and asynchronous modes set as references respectively. This result revealed that the direct correlation between the blended mode of interaction and the perceived presence of teaching in the ER online teaching of mathematics was .177 and .106 times higher than with the synchronous and asynchronous modes of interaction.

In exploring the extent to which gender and modes of interaction affected students' reported levels of teaching presence, the standard multiple regression analysis was performed and the results are presented in Table 3. Besides, the effect of the predictors R^2 was estimated using Cohen's (1988) guidelines. Cohen (1988) suggested ($R^2 = .02$) for small, ($R^2 = .15$) for medium and ($R^2 = .35$) large effect sizes. Following Tabachnick and Fidell (2013), multiple regression assumptions were not violated. For example, multicollinearity among the predictor variables was absent ($Tolerance > 2$) and the independence of errors satisfied ($Durbin\ Watson \approx 2$) (Garson, 2012).

Deducing from Table 3, the regression model for perceived teaching presence was statistically significant ($F\ (3, 448) = 17.121, p < .05$), which explained approximately 9.7% (R^2=.103, Adjusted R^2=.097) of the total variance. The explained variance means that the effect of gender and mode of interaction on the perceived teaching presence model was small.

Table 3 further showed that the relationship between the mode of interaction and teaching presence was positive, statistically significant, and insignificant. For statistically significant results, the asynchronous mode of interaction had a negative association with teaching presence in the ER online teaching of mathematics with blended mode set as the reference ($B = -.424, p < .05, t = -6.633, 95\%\ CI = \pm.281$) and with synchronous also set as reference ($B = -.397, p < .05, t = -5.804, 95\%\ CI = \pm.269$). This result indicates that the reported teaching presence in the asynchronous mode of interaction was .424 and .397 lower than the reported teaching presence in blended and synchronous modes, respectively.

Invariably, the synchronous mode ($B = .397, p < .05, t = 5.804, 95\%\ CI = \pm.269$) and blended mode ($B = .424, p < .05, t = 6.633, 95\%\ CI = \pm.252$) of interaction positively associated with teaching presence in the ER online teaching of mathematics with asynchronous mode set as the reference. This result indicates that the reported presence of teaching in a synchronous and blended mode of interaction was respectively.397 and .424 higher than the reported teaching presence in the asynchronous mode of interaction.

Table 3
Model significance and coefficients of regressions

Predictors	Coefficients			t	p	95% CI		Tol.
	B	SE	Beta			lower	upper	
Teaching presence	2.856	.052		54.862	.000	2.753	2.958	
Male students [a]	-.009	.055	-.008	-.169	.866	-.117	.098	.953
Synchronous mode [b]	-.027	.058	-.023	-.464	.643	-.141	.087	.845
Asynchronous mode [b]	-.424	.064	-.327	-6.633	.000	-.550	-.298	.823
Teaching presence	2.829	.055		51.752	.000	2.721	2.936	
Male students [a]	-.009	.055	-.008	-.169	.866	-.117	.098	.953
Asynchronous mode [c]	-.397	.068	-.306	-5.804	.000	-.532	-.263	.719
Blended mode [c]	.027	.058	.024	.464	.643	-.087	.141	.749
Teaching presence	2.432	.069		35.322	.000	2.296	2.567	
Male students [a]	-.009	.055	-.008	-.169	.866	-.117	.098	.953
Synchronous mode [d]	.397	.068	.333	5.804	.000	.263	.532	.607
Blended mode [d]	.424	.064	.378	6.633	.000	.298	.550	.616
Model fit								
R^2	.103							
Adjusted R^2	.097							
R^2 change	.103							
Durbin Watson	1.547							
F	17.121							
p	.000							

Note: *SE=standard error; CI=Confidence interval; Tol. = Tolerance; Outcome variable = perceived teaching presence*
Referenced variables *(a = female; b = blended mode; c = synchronous; g = asynchronous).*

Algebraically, the statistically significant associations were modelled as follows (taking TP = teaching presence; a = asynchronous mode; s = synchronous mode; b = blended modes of interaction):

$TP = 2.856 - .424a$ (1) Setting blended interaction as reference

$TP = 2.829 - .397a$ (2) Setting synchronous interaction as reference

$TP = 2.432 + .397s + .424b$ (3) Setting asynchronous interaction as reference

From equation 1 and 2, a unit increase in asynchronous modes of instruction resulted in a reduction of about .424 units and .397 units in perceived teaching presence, taking blended and synchronous modes respectively constant. That is if mathematics teachers had traded-off synchronous and blended interaction modes of interaction for asynchronous interaction in the ER teaching, the sense of mathematics teaching presence would have reduced by approximately 39.7% and 42.4%, respectively. Similarly, equation 3 showed that a unit increase in synchronous and blended modes of instruction resulted in an increase of about .424 units and .397 units in perceived teaching presence taking asynchronous modes of instruction constant. That is if mathematics teachers had abandoned asynchronous mode of interaction for synchronous and blended interaction modes of interaction, the impression of teaching presence would have increased by approximately 39.7% and 42.4%, respectively.

DISCUSSION

This study has added to existing literature that the presence of teaching can be experienced by students learning mathematics in an ER online set-up that is devoid of the physical presence of teacher-student interactions (Picciano, 2002; Zhang et al., 2016). Similar to the high rating of teaching presence by in-service educators enrolled in online professional development (Miller et al., 2014), most of the students (over 80%) in this study experienced moderate to high mathematics teaching presence in the ER online mathematics teaching. Suspected inadequate training for mathematics teachers in using online mathematics tools did not hamper mathematics teachers' ability to organize, design, facilitate, and direct cognitive and social processes to realize meaningful and educationally worthwhile learning outcomes. Thus, during the ER online teaching, mathematics teachers might have been able to identify the mathematics learning needs of students, monitored or managed collaborative and reflective work, averted undirected discourse, and provided the needed guidance and learning activities. The findings in this study seem to contradict the conclusions arrived by Zweig and Stafford (2016) who observed that online instructors have difficulty supporting student involvement and persistence, and deficient in providing their students with the greatest support possible perhaps because the instructors got training while they were teaching online – a possible sign of poor training.

The study further showed that despite the equal access to the ER online teaching of mathematics to all students, more female students experienced moderate to high teaching presence than male students. The reason could be female students had a greater need to experience mathematics teaching presence to stay engaged and motivated in the ER online teaching because of their weakness in mathematics achievement (Morante et al., 2017) or inexperience in online learning (Ashong & Commander, 2012). Also, the mathematics instructor's guidance that averted undirected monologues, ensured fruitful mathematical discussions; provided cognitive activation, and provided individual student or group support were maybe more welcomed by female students. The male students may be accustomed to teaching presence elements in online classes and take those elements for granted. Besides, the male students may have become proficient as online learners even if their previous online experiences lack teaching presence elements.

Despite the reported differences in the students' sense of mathematics teaching presence, this study has shown that gender was not a significant predictor of teaching presence in the ER online mathematics teaching. Whiles this finding agreed with Laves' (2010) assertion that students' perception of teaching presence does not relate to their gender, it also confirmed Garrison's (2017) claim that gender does not predict the sense of teaching presence in an ER online mathematics teaching. This result maybe because both male and female students had a similar need to experience mathematics teaching to stay engaged and motivated in the ER online teaching. Also, the mathematics teachers' guidance that averted undirected monologues; that ensured fruitful mathematical discussions; provided cognitive activation; and provided individual student or group support appealed to both male and female students alike. As reported elsewhere (Almasi et al., 2018) both female and male students perceive teaching presence in the same way. Hence, it can be concluded that students' perception of teaching presence is irrespective of their gender.

Regarding the mode of interactions, the study showed that students taught with only asynchronous modes experienced less teaching presence than students taught through either the synchronous or blended modes. This observation is in line with previous studies in that synchronous modes facilitated real-time communication, collaboration and prompt feedback (Duncan et al., 2012; Higley, 2013), which makes synchronous and blended modes of online interaction provide an impression of immediacy for establishing presence (Chen & Wang, 2018; Duncan et al., 2012; Garrison, 2017; Sife et al., 2007). Comparatively speaking, students who study via a blended learning method show superior conceptual comprehension (Setyaningrum, 2018). The students in the study conducted by Setyaningrum (2018) asserted that they can access learning materials at any moment and go over some challenging subject again. Since the teaching of mathematics (Geometry in particular) requires hands-on practice and prompt feedback, student-teacher interaction, communication, and imitation, it stands to reason that synchronous and blended modes of interaction are adequate for establishing a presence. Consequently, this study could not confirm the claim by Shea et al. (2006) that asynchronous learning environments attract more students to online learning. Instead, the presence of mathematics teaching was maximized if there was dialectic real-time discourse as it pertained to conventional face-to-face classroom instruction.

Moreover, this study has showed that the mode of interaction was statistically a significant predictor of teaching presence although the effect size of 9.7%, as suggested by Cohen (1988) was small. A possible explanation for this small effect could be that mathematics teaching was low because Serdyukov and Serdyukova (2015) has opined that the mode of interaction does not matter as much as the teaching. Thus, if mathematics teaching was high, teaching presence would be high.

Another important finding in this study was that asynchronous interaction mode dampened the sense of mathematics teaching presence. Synchronous and blended modes of interaction rather enhanced the perceived sense of mathematics teaching presence during the ER online teaching. No wonder the synchronous and blended modes of interaction were dominantly applied during the ER online teaching of mathematics (as discussed earlier in the results). This finding also supports the work of other studies (Weissman, 2017) that showed that synchronous and blended modes of interaction are more effective in promoting teaching presence in online teaching. A possible explanation for this result might be that teaching activities associated with the conventional face-to-face are comparable to those in synchronous and blended modes of interaction (Taylor-Guy & Chase, 2020). Admittedly, synchronous and blended modes of interaction in the ER online mathematics teaching supported video-conferencing, instant messaging and chat. Hence, the students could ask questions, pose comments, practice solution strategies and got immediate feedback from their mathematics teachers.

CONCLUSIONS

To a considerable extent, this study has shown that during the ER online mathematics teaching, mathematics teachers were able to identify the mathematics learning needs of students, monitored or managed collaborative and reflective work, averted undirected discourse, and provided the needed guidance and learning activities. This conclusion was reached after discovering that 82.7% of the college students sensed mathematics teaching at a moderate to high level. Thus, mathematics teachers' ability to organize, design, facilitate, and direct cognitive and social processes to realize meaningful and educationally worthwhile learning outcomes was ranked moderate to high. For teachers to make teaching present to students who experienced low teaching presence (N = 78, 17.3%), this study suggests the following actions. It is suggested that students are provided with regular reminders on impending due dates. Also, teachers should provide constructive feedback in real-time, organize and design easy-to-navigate learning platforms for ER online mathematics teaching as proposed by Volchok (2017). When this is done, teachers will ensure students' satisfaction and successful learning in mathematics and ensure inclusive education.

Since gender was not a function of teaching presence in ER mathematics teaching, teachers should strive for gender balance in instructional management, direct instruction, and building understanding of discourse in online mathematics teaching. However, such practices will contradict policy decisions that advocate for female empowerment in mathematics-related courses (Ministry of Education, 2016, 2018b). The study has shown that unlike synchronous and blended modes of interaction, asynchronous mode of online interaction dampened students' sense of teaching presence in the ER online teaching of mathematics. Therefore, to fulfil the expectation of teaching presence – to connect students mentally, emotionally and physically in the teaching endeavor (Rodgers & Raider‐Roth, 2006), synchronous and blended modes of interaction are recommended for ER online learning of mathematics. However, since the asynchronous mode of interaction cannot be eliminated in online instruction, mathematics teachers should endeavor to provide more text-based, and audio-visual materials and feedback should also be provided in real-time.

This ER online teaching was not an initially planned mode for mathematics instruction. Hence, many considerations necessary for designing and implementing effective online teaching in mathematics were taken for granted. Therefore, the comparison of the findings in this study with well-planned online mathematics instruction should be moderate. Besides, the selection of college students was not randomized; hence the responses collected from the students may rarely be perfect. Therefore, users of the findings reached in this study should be moderate in their generalization.

Additionally, my inability to enroll on the students' learning platforms made it challenging to assign practical reasons why college students in Ghana had a moderate perception of teaching presence. Hence, the reasons assigned to the observations are born out of intuitions and reflections. More so, the inability to deduce the three elements of teaching presence in this study adds to researchers' concern about the conceptualization of teaching presence concerning the items measuring the scale and contextual factors that might affect teaching presence. Since a small percentage of the variance in online mathematics teaching presence was explained by the modes of interaction, it is recommended that further study be conducted to ascertain other variables that can essentially predict online teaching presence in mathematics.

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BIBLIOGRAPHY

Agormedah, E. K., Henaku, E. A., Ayite, D. M. K., & Ansah, E. A. (2020). Online learning in higher education during COVID-19 pandemic: A case of Ghana. *Journal of Educational Technology & Online Learning*, *3*(3), 183–210.

Almasi, M., Zhu, C., & Machumu, H. (2018). Teaching, social, and cognitive presences and their relations to students' characteristics and academic performance in blended learning courses in a Tanzanian University. *Afrika Focus*, *31*(1), 73–89. https://doi.org/10.21825/af.v31i1.9038

Arbaugh, J. B., Cleveland-Innes, M., Diaz, S. R., Garrison, D. R., Ice, P., Richardson, J. C., & Swan, K. P. (2008). Developing a community of inquiry instrument: Testing a measure of the Community of Inquiry framework using a multi-institutional sample. *Elsevier*, *11*(3–4), 133–136. https://doi.org/10.1016/j.iheduc.2008.06.003

Ashong, C. Y., & Commander, N. E. (2012). Ethnicity, gender, and perceptions of online learning in higher education. *MERLOT Journal of Online Learning and Teaching*, *8*(2).

Caskurlu, S. (2018). Confirming the subdimensions of teaching, social, and cognitive presences: A construct validity study. *The Internet and Higher Education*. https://doi.org/10.1016/j.iheduc.2018.05.002

Caskurlu, Secil, Maeda, Y., Richardson, J. C., & Jing, L. (2020). A meta-analysis addressing the relationship between teaching presence and students' satisfaction and learning. *Computers & Education*, *157*, 1–16.https://doi.org/10.1016/j.compedu.2020.103966

Chen, C. M., & Wang, J. Y. (2018). Effects of online synchronous instruction with an attention monitoring and alarm mechanism on sustain attention and learning performance. *Interactive Learning Environments*, *26*(4), 427–443. https://doi.org/10.1080/10494820.2017.1341938

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. In *New York* (2nd Ed). Lawrence Erlbaum Associates.

Duncan, K., Kenworthy, A., & McNamara, R. (2012). The effect of synchronous and asynchronous participation on students' performance in online accounting courses. *Accounting Education*, *21*(4), 413–449. https://doi.org/10.1080/09639284.2012.673387

Epp, C. D., Phirangee, K., & Hewitt, J. (2017). Student actions and community in online courses: The roles played by course length and facilitation method. *Online Learning Journal*, *21*(4), 53–77. http://dx.doi.org/10.24059/olj.v21i4.1269

Field, A. P., Miles, J., & Field, Z. (2012). *Discovering statistics using R.* SAGE Publications Inc.

Garland, D., & Martin, B. (2005). Do gender and learning style play a role in how online courses should be designed? *Jornal of Interactive Online Learning*, *4*(2), 67–81.

Garrison, D. R. (2017). *E-learning in the 21st century: A community of inquiry framework for research and practice.* (3rd ed.). Taylor & Francis.

Garrison, D. R., Cleveland-Innes, M., & Fung, T. S. (2010). Exploring causal relationships among teaching, cognitive and social presence: Student perceptions of the CoI framework. *The Internet and Higher Education*, *13*(1–2), 31–36. https://doi.org/10.1016/j.iheduc.2009.10.002

Garrison, D. R, & Akyol, Z. (2013). Th e Community of Inquiry Theoretical Framework. In *Handbook of distance education* (pp. 122–138). Routledge.

Garrison, D. Randy, Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, *2*(2–3), 87–105. https://doi.org/10.1016/S1096-7516(00)00016-6

Garrison, D Randy, Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education*, *15*(1), 7–23. https://doi.org/10.1080/08923640109527071

Garson, G. D. (2012). *Testing statistical assumptions* (Blue Book). Statistical Associates Publishing.

Goralski, M. A., & Falk, L. K. (2017). Online vs brick and mortar learning: Competition or complementary. *Competition Forum*, *15*(2), 271–277.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (7th ed.). Prentice-Hall.

Hegeman, J. S. (2015). Using instructor-generated video lectures in online mathematics courses improves student learning. *Online Learning*, *19*(3), 70–87. http://dx.doi.org/10.24059/olj.v19i3.669

Higley, M. (2013). Benefits of synchronous and asynchronous e-learning. *Free E-Learning Industry*.

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). *The difference between emergency remote teaching and online learning.*

Holt, D. E. (2020). *Establishing teaching presence in higher education online mathematics courses: A phenomenological study*. Nova Southeastern University.

Jaggars, S. S. (2014). Choosing between online and face-to-face courses: Community college student voices. *American Journal of Distance Education*, *28*(1), 27–38. https://doi.org/10.1080/08923647.2014.867697

Kyei-Blankson, L., Ntuli, E., & Donnelly, H. (2019). Establishing the importance of interaction and presence to student learning in online environments. *Journal of Interactive Learning Research*, *30*(4), 539-560. https://doi.org/10.22158/wjer.v3n1p48

Laves, E. (2010). *The impact of teaching presence in intensive online courses on perceived learning and sense of community*. University of Nebraska.

Liang, L., Yeung, K., Lui, R. K. W., Cheung, W. M. Y., & Lam, K. F. (2018). Lessons Learned from a Calculus E-Learning System for First-Year University Students with Diverse Mathematics Backgrounds. *Distance Learning, E-Learning and Blended Learning in Mathematics Education*, 69–92. https://doi.org/10.1007/978-3-319-90790-1_5

Little-Wiles, J., Fernandez, E., & Fox, P. (2014). Understanding gender differences in online learning. *IEEE Frontiers in Education Conference (FIE) Proceedings*, 1–4.

MacGillivray, H. (2008). Learning support and students studying mathematics and statistics in Australian universities. In *Taylor & Francis*.

Miller, M. G., Hahs-vaughn, D. L., & Zygouris-coe, V. (2014). A confirmatory factor analysis of teaching presence within online professional development. *Journal of Asynchronous Learning Networks*, *18*(1).

Ministry of Education [MoE]. (2016). *T-TEL professional development programme. Theme 6: National teachers' standards and teacher education curriculum framework (Professional development guide for tutors)*. Ministry of Education.

Ministry of Education [MoE]. (2018a). *Four-year B.Ed. course Manual Learning: Teaching and Applying Geometry and Handling Data*. National Council for Tertiary Education.

Ministry of Education [MoE]. (2018b). *The gender handbook for teaching practice mentors – Gender responsive resources for teaching practice mentors*. Ministry of Education.

Morante, A., Djenidi, V., Clark, H., & West, S. (2017). Gender differences in online participation: Examining a history and a mathematics open foundation online course. *Australian Journal of Adult Learning*, *57*(2), 266–293.

Nyabor, J. (2020). Coronavirus: Government bans religious activities, funerals, all other public gatherings. *Citi Newsroom*.

Ogbonna, G. C., IbezimI, E. N., & Obi, A, C. (2019). Synchronous versus asynchronous e-learning in teaching word processing: An experimental approach. *South African Journal of Education*, *39*(2). https://doi.org/10.15700/saje.v39n2a1383

Omona, J. (2013). Sampling in Qualitative Research: Improving the Quality of Research Outcomes in Higher Education. *Makerere Journal of Higher Education*, *4*(2), 169–185. https://doi.org/10.4314/majohe.v4i2.4

Phelps, G., & Howell, H. (2016). Assessing mathematical knowledge for teaching: The role of teaching context. *The Mathematics Enthusiast*, *13*(1), 52–70.

Picciano, A. G. (2002). Beyond student perceptions: Issues of interaction, presence, and performance in an online course. *Journal of Asynchronous Learning Networks*, *6*(1), 21–40.

Rodgers, C. R., & Raider-Roth, M. B. (2006). Presence in teaching. *Teachers and Teaching: Theory and Practice*, *12*(3), 265–287. https://doi.org/10.1080/13450600500467548

Rovai, A. P. (2002). Building Sense of Community at a Distance. *The International Review of Research in Open and Distributed Learning*, *3*(1), 23. https://doi.org/10.19173/irrodl.v3i1.79

Seaton, K. A., King, D. M., & Sandison, C. E. (2014). Flipping the maths tutorial: A tale of n departments. *Australian Mathematical Society Gazette*, *41*(2), 99–113.

Serdyukov, P., & Serdyukova, N. (2015). Effects of communication, socialization and collaboration on online learning. *European Scientific Journal*, *11*(10).

Setyaningrum, W. (2018). Blended learning: Does it help students in understanding mathematical concepts? *Jurnal*

Riset Pendidikan Matematika, *5*(2), 244–253. https://doi.org/10.21831/jrpm.v5i2.21428
Shea, P., Li, C. S., & Pickett, A. (2006). A study of teaching presence and student sense of learning community in fully online and web-enhanced college courses. *The Internet and Higher Education*, *9*(3), 175–190. https://doi.org/10.1016/j.iheduc.2006.06.005
Sife, A., Lwoga, E., & Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries. *International Journal of Education and Development Using ICT*, *3*(2), 57–56.
Tabachnick, B. G., & Fidell, l. S. (2013). *Using multivariate statistics* (6th ed.). Pearson.
Taylor-Guy, P., & Chase, A. M. (2020). Universities need to train lecturers in online delivery, or they risk students dropping out. *The Conversation*.
Timm, N. H. (2004). Principal component, canonical correlation, and exploratory factor analysis. In *Applied multivariate analysis II* (pp. 446–514). Springer. https://doi.org/10.1007/978-0-387-22771-9_8
Tran, D., & Nguyen, G. N. . (2021). Presence in online mathematics methods courses: Design principles across institutions. In K. Hollebrands, R. Anderson, & K. Oliver (Eds.), *Online Learning in Mathematics Education* (eds, pp. 43–63). Springer, Cham. https://doi.org/10.1007/978-3-030-80230-1_3
Volchok, E. (2017). Towards a predictive model of community college student success in blended classes. *Community College Journal of Research and Practice*, *42*(4), 271–288. https://doi.org/10.1080/10668926.2017.1287607
Wang, Y., & Stein, D. (2021). Effects of online teaching presence on students' cognitive conflict and engagement. *Distance Education*, *42*(4), 547–566. https://doi.org/10.1080/01587919.2021.1987837
Watkins, M. W. (2000). *Monte Carlo PCA for Parallel Analysis (Computer Software)... - Google Scholar*. Ed & Psych.
Weissman, N. (2017). *Evaluating the effectiveness of a synchronous online environment in establishing social, cognitive, and teaching presence*. Kent State University.
Yu, T., & Richardson, J. C. (2015). Examining reliability and validity of a Korean version of the community of inquiry instrument using exploratory and confirmatory factor analysis. *The Internet and Higher Education*, *25*, 45–52. https://doi.org/10.1016/j.iheduc.2014.12.004
Zhang, H., Lin, L., Zhan, Y., & Ren, Y. (2016). The impact of teaching presence on online engagement behaviors. *Journal of Educational Computing Research*, *54*(7), 887–900. https://doi.org/10.1177/0735633116648171
Zijlmans, E. A. O., Tijmstra, J., van der Ark, L. A., & Sijtsma, K. (2018). Item-score reliability in empirical-data sets and its relationship with other item indices. *Educational and Psychological Measurement*, *78*(6), 998–1020. https://doi.org/10.1177/0013164417728358
Zweig, J., & Stafford, E. (2016). Training for online teachers to support student success: Themes from a survey administered to teachers in four online learning programs. *Journal of Online Learning Research*, *2*(4), 399-418.