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Bringing the Neuroscience of Learning to Online Teaching: Brain Breaks on Students' Perception of Engagement by Gender

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Abstract: Currently, the exploration of the impact of Brain breaks in online or virtual (synchronous) classroom instruction has remained limited in number, especially since there is less evidence that compares several types of brain breaks and their effectiveness with students' engagement by gender. To redress this research gap, this study is two-fold: 1) to examine the effect of both short physical and mental types of brain breaks on the perception of engagement in online (synchronous) classroom instruction, and 2) to specifically examine the moderation effect of types of brain breaks by gender. Data from 218 middle school students were collected during their online (synchronous) class. The overall results indicate that female and male students perceive a different level of engagement following the implementation of physical and mental Brain breaks. Furthermore, female students responded well to mental Brain Breaks in terms of their academic performance. The findings deepen our understanding of how active breaks during instruction in the classroom have a positive influence on students' engagement.

Keywords: *Brain Break, Physical, Mental, Online Instruction, Engagement.*

1. INTRODUCTION

COVID-19 precautions have profoundly changed the way teachers teach and all teachers are bracing for the possibility of having to teach remotely for some part of the academic year. This shift came with many challenges in teaching and learning and one of them is how to keep the students engaged and motivated in their academic tasks in an online classroom. Therefore, teachers adopted a variety of activities that allowed the students to be focused during the long online classroom settings such as brain breaks. Brain breaks are "a short, simple break from learning that may be implemented within classroom instructions" (Weslake & Christian, 2015, p. 17). Evidence has shown that active breaks during instruction in the classroom have a positive influence on students' engagement (Voss et al., 2011; Weslake & Christian, 2015). Numerous studies have focused on the exploration of the effects of short and active brain breaks on students' academic achievements in classrooms, for example, Westlake and Christian (2015), mapped several types of physical brain breaks against student enjoyment/engagement, and found a positive impact on learners' motivation (Mura et al., 2015; Westlake & Christian, 2015).

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The exploration of the impact of brain breaks in online or virtual (synchronous) classroom instruction has remained limited in number. Additionally, physical brain breaks are the most used in the classroom (Dinkel, 2017; Popeska, 2018), but no evidence compares distinct types of brain breaks and their effectiveness with students' engagement by gender for example mental breaks. Therefore, the aim of this study is two-fold. 1) to examine the effect of both short physical and mental types of brain breaks on the perception of engagement in online (synchronous) classroom instruction, and 2) to specifically examine the moderation effect of types of brain breaks by gender. In the model, first, the association between using the brain breaks in online (Synchronous) classrooms and perception of engagement is examined. Gender is then added to the model to test the interaction effects of gender on the type of brain breaks.

2. LITERATURE REVIEW

In the past few decades' educators have explored many of the findings from neuroscience research and applied them to the classroom with claims of improved learning (Mostert & Beam, 2010; Spaulding et al., 2010). One of them is incorporating breaks during instruction so that optimal learning is achieved by students. A brain break is one of them and, defines as "a short, simple break from learning that may be implemented within classroom instructions" (Weslake & Christian, 2015, p. 17). Stephenson (2009) concedes that brain breaks may increase alertness" (p. 119). There is, however, documented evidence that giving students a break during lessons using well-developed activities provides positive impacts on students' reading comprehension (Greany & Rodd, 2003; Norman, 2003).

I grounded my work in the theory of expectancy and value. The expectancy-value theory was developed by John Williams in the 1960s to understand the achievement motivation of individuals. In 1983, Jacquelynn Eccles expanded this research into the field of education. According to expectancy-value theory students' achievement-related choices are mostly determined by two factors: students' expectation of success and the value that students place on a task (Eccles et al., 1983).

This current research was specifically focused on how the student values the task important, useful, and enjoyable with a Brain break in the classroom. If the students are engaged in the classroom, then they will value the academic tasks (Leaper, 2011). Empirical studies suggest that valuing the task predicts important outcomes such as engagement, continuing interest, and motivation The model further differentiates task value into four components (Eccles et al., 1983): *attainment value* (i.e., the importance of doing well), *intrinsic value* (i.e., personal enjoyment), *utility value* (i.e., perceived usefulness for future goals), and *cost* (i.e., competition with other goals). Additionally, this current research focuses on the intrinsic value and attainment value of the academic task. If students do not value, the task then it makes it hard for the teacher to understand or evaluate the student's response. However, if the value of the task is increased by linking the task to students' interests, including specific activities that allow their brain to energize, providing short breaks, or including a pause, then

these could play a vital role in students' engagement. The hypothesis or premise is that if the students are engaged in the tasks, then they will likely value the tasks more and be successful.

2.1. Brain Breaks in the Classroom

One way the physical and mental activities are incorporated into instruction is through Brain breaks, which aim to engage and motivate students in the classroom (Baker et al., 2017, p. 539) to perform their academic tasks properly. Incorporating structured movements in learning increases the oxygen in the bloodstream which can in turn improve students' concentration and readiness to learn (Teaching Expertise, 2004). Using brain breaks helps teachers to provide the information in smaller segments and at more regular intervals. Expecting children to focus for extended periods without a break is unreasonable, which is why brain breaks are so popular.

Several studies have been conducted to examine the impact of physical brain breaks at elementary and middle school levels and have proven to positively improve academic achievements and improve students' focus on tasks. For example, according to We slake and Christian's research in 2015 with elementary students, brain breaks allowed students to be "in the most receptive state for learning" (p. 2). Additionally, the state that the brain breaks are another form of changing the physical and mental state of learners in the classroom. Townsend (2004) reported that during instruction, students' concentration can cause physical and emotional tension and that brain breaks reduced this tension and allowed students to remain in the instructional level of learning. However, Weslake & Christian (2015) focused on physical movement in their research study in one elementary school's classroom, but there is less evidence that compares other types of brain breaks such as mental brain breaks, and their effectiveness in promoting student refocus on their tasks after the brain break is complete.

Similarly, a few other types of research for example Greany & Rodd (2003); Mulrine et al., (2008) studied a sample of students to determine whether exercise and movements in the form of Brain Gym® in the classroom show a positive effect on students' enjoyment during learning. They found a positive impact on their academic performance, as well as their academic focus on behaviors in the classroom. Research has suggested that students participating in physical brain breaks display improved academic performance in core subjects such as mathematics and English, as well as in academic standardized tests (Álvarez-Bueno et al.,2016; Ahamed et al., 2007). Additionally, teachers have supported that brain breaks have been shown to increase students' perceived competence and raise classroom motivational levels (Vazou et al., 2012).

As mentioned above, studies have focused largely on the relationship between physical movement and students' engagement in a face-to-face classroom, however, the impact of other types of brain breaks on students' engagement and focus in the classroom has remained unexplored. Therefore, this current research uses the data from physical and mental brain

breaks in middle school students in an online class and compares their effects on male and female students.

2.2. Types of Brain Breaks

There are a variety of brain break activities that educators have identified and these can be categorized into two groups: those based on vigorous physical activity and those which focus on mental activity, plus any combination of the two, for example standing and pretending to ride a surfboard while enjoying the feeling of skimming over the waves (Gay, 2013). Physical brain breaks have a vigorous physical component. Incorporating a physical element into brain breaks allows students to alleviate stress, improve physical fitness, and develop fine and gross motor skills (Teaching Expertise, 2004). Jensen (2005) presented a convincing case for movement to be integrated into everyday learning but suggested that not all breaks must be high activity as even standing up or stretching adds value to learning. Mental brain breaks take a variety of forms and may be used to increase focus and/or improve fine motor skills (Maskell, et al., 2004). This study uses physical Brain breaks where movement is involved such as physical exercises, and mental Brain breaks may not have movement involved and take the form of a learning game or similar activity.

2.3. Online Class as Milieu

In a recent study, Waal (2020) stated that the experience of online learning for many students is characterized by prolonged periods of sitting down, and in many cases, teachers hold the expectation in synchronous classes for students to sit still in front of a computer for extended periods and learn. Sitting for extended periods makes it difficult to concentrate and can lead to physical exhaustion, irritability, and eye strain. Additionally, sitting for extended periods can reduce the student's engagement in the class, and affect students' emotional and mental health. Waal (2020) added that using a short brain break may improve students' concentration and level of engagement as is proven in traditional face-to-face classrooms.

Popeska et al., (2018) evaluated the effectiveness of brain break videos on interest and motivation for physical activity among school children and the contribution of such videos to learning for health. During this study student's watched Brain break videos on the computer, exercise them, and the study confirms the positive effect of the application of Brain breaks videos on students' health. Popeska et al. (2018) further claimed that these Brain break videos can be used in online instruction to enhance students' learning on learning.

More recently, when examining the effects of brain breaks on learning in the classroom, Mok et al. (2020) presented a framework for the implementation of brain breaks that can be applied in online (virtual) classrooms in grades K-12. This framework was developed using brain breaks activity for four months in eight different countries. They supported that brain breaks in online classrooms enhanced learning experiences, attitudes towards engagement, and students' motivation. Their research emphasized the use of interactive, technology-based exercise videos that can be easily integrated into synchronous classroom settings. Based on

Mok et. al. (2020) framework, this study determines the effects of brain breaks on students' cognitive, and behavioral learning from teachers' perspectives.

2.4. Gender as a Moderator

It is believed that male and female students may have different biological requirements; Generally, boys might respond more to physical activities, and girls might respond more to mental activities (Rodán, 2019). This has been attributed to gender differences in cognitive ability associated with processing information (Rodán, 2019). Gender difference in responding to the brain breaks in the classroom has not been uncovered yet and none of the sample size from the previous on the effects of brain break in the traditional face-to-face classroom provide us the breakdown of their findings in terms of male and females' responses. However, previous research such as Waal (2020) and Weslake and Christian (2015) studies showed a positive effect on all students' engagement levels after implementing the brain breaks. Due to no information available related to the impact of gender on Brain breaks, research is needed to examine the relationship between types of brain breaks and perception of engagement in online classrooms moderated by gender. This current research is, specifically, focused on looking at the moderation effect of types of brain breaks by gender.

2.5. Current Study and Research Questions

In the light of the above-referenced context, this study examines the relationship of using both physical and mental brain breaks in online (synchronous) classroom instruction and their perceived effects on students' engagement and motivation moderated by gender. The research hypothesis for this investigation is:

H1) Brain breaks help students feel engaged and motivated in an online(synchronous) classroom.

H2) The relationship between the students' motivation and engagement with thedifferent types of brain breaks is positive.

H3) There is a positive relationship between engagement and the type of brainbreaks moderated by gender.

3. METHODOLOGY

3.1. Participants

Data for this study were obtained from the students who attended online (synchronous) classes at the community-based school in Central Texas, USA. Participants included 234 middle school students (118 girls and 117 boys) aged 13 -15 years from 7th and 8th grade. In total 24 classes from 4 randomly selected classes in community-based schools were recruited.

All students in the recruited classes were invited to participate with their parent's approval. All two hundred and thirty-four participated in the survey and filled the questionnaire (responses rate was 100%) on a Google form after implementing a brain break in their respective online classroom. However, sixteen students were excluded from the analysis due to a questionnaire that was not filled out. Therefore, the final sample consisted of 218 students. The same questionnaire was prepared and distributed for both types of brain breaks being observed, an online platform and an in-person classroom setting.

3.2. Procedures

The data used in this current study were collected from middle school students after implementing two diverse types of brain breaks, Physical brain breaks, and Mental brain breaks. Students for all participating online classrooms were administered a questionnaire during school hours. All the students from the participating classes filled out 6 total questionnaires to assess their perception of engagement in online classes. All the questionnaires were the same for physical and mental brain breaks and each questionnaire took 6 minutes for each student to fill out. As teachers were new to online instruction, the first Principal organized a meeting with teachers working in these online classes, and I explained the purpose and the procedures of this study. Then teachers prepared 3 Physical and 3 Mental brain break activities for the participating classes and then they conducted them simultaneously in all 4 random classes at the same time. Each brain break activity type was put into practice for one week. During that week a different activity of that type was implemented three days a week. One five-minute brain break was taken during each online class.

3.3. Measure

Measures were taken to ensure the order of activities was random and would not influence the results. Researchers focused on three variables: types of brain breaks, gender effect, and the outcome engagement, among middle school students in an online class. In the questionnaire, initially, 5 items (questions) were created to measure the perception of engagement of each student in an online classroom with two different kinds of brain breaks with the option to select "very satisfied," "somewhat satisfied," a "Neutral", "somewhat dissatisfied," or "very dissatisfied." However, after a reliability analysis test, in our analysis, only four items with a Cronbach's alpha of .89 were highlighted. Students' responses were then coded on a scale of 1 to 5 with 1 being "very dissatisfied" and 5 being "very satisfied. The 4 items are 'what describes your experience with brain break in an online class?', 'how does your attitude towards the classroom change after you have participated in a brain break session? 'how do you feel participating in a classroom task after you had participated in a brain break session during an online class? 'with brain breaks in an online class?' 'are you interested in continuing this brain break in an online class? These items (questions) are prepared to assess the perception of engagement according to the expectancy-value theory.

The mean of the responses was 4.035 with a standard deviation of .96. The reliability of the scale was high with a Cronbach's alpha of 0.89.

Table 1. *Items with Mean and Cronbach's Alpha*

Items	Mean	SD	Cronbach's Alpha
What describes your experience with Brain Breaks in a virtual classroom	3.89	.75	.95
What did you like or dislike about this brain break?	3.92	.54	.83
How is your attitude towards the classroom after we have had a Brain Break?	3.83	.49	.78
How did you feel after we had Brain Break in class?	3.96	.67	.89
To what extent we should continue the Brain breaks	3.89	.68	.85

3.4. Variables

The study focused on three variables: types of brain breaks, gender effect, and the outcome engagement, among middle school students in an online class. In this study, gender was used as a moderator; it was coded using dummy coding (female:1 and male: 0). Types of brain breaks are used as an independent variable named (e.g., physical, mental) and coded using dummy coding (Physical brain break: 0, Mental brain break 1) and engagement is used as the dependent variable, and it is calculated by taking the average of four items' responses.

Table 2. *Descriptive Statistics of Students' Engagement with Brain Breaks and Gender*

Variable	Observation	Mean	St. D	Min	Max
Age	218	14.27	0.7	13	15
BB_C	218	0.5	0.5	0	1
Gender_ C	218	0.52	0.5	0	1
BB_C*Gender _C	218	0.26	0.44	0	1
Engagement	218	4.04	0.98	1.5	5

Table 3. *Correlation on Students' Engagement with Types of Brain Breaks and Gender*

Variables	Age	BB_C	Gender _ C	BB_C* Gender _C	Engagement
Age	1.00				
BB_C	0.014	1.00			
Gender_ C	0.114	0.00	1.00		
BB_C* Gender_C	0.065	0.59	0.569	1.00	
Engagement	0.259	0.20	0.198	0.4112	1.00

3.5. Plan of Analysis

Data was collected on the variable, perception of engagement (outcome) was calculated by getting the average of 4 items (questions) responses. To determine the relationship between the types of brain breaks and the perception of engagement, and how this relationship is moderated by gender, two regression models were built, and the combined equation is;

1. Engagement = $\beta 0 + \beta 1$(Brain breaks) + $\beta 2$(Gender)+$\beta 3$(Brain break*Gender) +ei

Within this model, a grand mean is represented by $\beta 0$ shows the average engagement level of students with implementing Brain breaks. $\beta 1$ is the regression coefficient for the type of brain breaks those teachers implemented in an online class, and $\beta 2$ is the regression coefficient for the gender effect. The dummy coding was created for the type of brain breaks, for Physical is 0 and for Mental is 1. Dummy coding was also created for gender, for males is 0, and for females is 1.

Table 4. *Dummy Coding for Gender and Types of Brain Breaks*

Gender	Contrast 1	Contrast 2
Male	0 , 0	0 , 1
Female	1 , 0	1 , 1
Type of Brain Breaks	Physical BB	Mental BB

The scores for the perception of engagement for Females and Males with these two types of brain breaks were obtained by using the above-mentioned equation. Dummy codes were used

to get the engagement scores and presented in the form of a graph (figure 1) in the result section.

4. FINDINGS

This research investigated the relationship between perception of engagement and types of brain break that was implemented in an online class, and whether this relationship was moderated by gender. From the descriptive statistics, we can infer those participants started with a relatively high outcome (perception of engagement) (M: 4.03, SD: .98). Based on these descriptive statistics that ranged from a scale of 1-5, the results indicated that the lowest score reported is 1.5 and the maximum interest is 5.

Table 2 and 3 shows descriptive statistics and correlation for our study variables. Table 5 displays the results of our moderated regression, which was used to test the hypotheses. First, I tested the hypothesis (H1) to examine the overall effect of Brain breaks on the perception of engagement. I conducted a simple regression model and analysis revealed a positive significant relationship between the perception of engagement and the brain breaks (R^2=4%, F (1, 216) =4.19, p<.040) as shown in Table 5. This relationship is statistically significant from zero, but the effect is small.

Then I added the predictor type of Brain break to test hypothesis 2 (H2) to examine the relationship between the perception of engagement with a physical and mental Brain break. I proceeded with a regression model that revealed a significant relationship between mental Brain breaks and the perception of engagement in an online class. This relationship is statically significant from zero (R^2=9%, F (2, 215) =4.19, p<.018). This result shows a 9% variability of perception of engagement by adding mental brain breaks in the model. Further, a predictor gender (female and male) was added to investigate the moderation effect of the type of brain break by gender. To test this hypothesis (H3) I continued with the regression model and the analysis revealed a large and statically significant moderation effect of types of brain breaks by gender on perception of engagement. The results supported those female students were more engaged than male students and the results were statically significant. In addition, the result supports those female students showed more engagement levels after mental Brain breaks were implemented as analysis reveals that every 1-unit increase in mental Brain breaks resulted in a 1.23 unit change in female students' engagement level in an online class. The overall model shows the 18% variability in the perception of engagement explained by types of brain breaks and the effect of gender (R^2=18%, F (3, 214) =6.96, p<.003). However, the moderation effect of the type of brain break by gender was 10% and it is statistically significantly different from zero (R^2=10%, F (1, 213) =11.9, p<.001).

Table 5. *Regression Model for Perception of Engagement by the Moderation Effect of Gender on Types of Brain Breaks*

Source	SS	df	p	F	R^2
Intercept	16.96	1	0.04	4.19	4%
Brain Break _C	12.49	1	0.02	4.19	9%
Gender_ C	211.83	1	0.001	6,96	18%
Brain Break _C *Gender _C	273.45	373	0.003	11.9	10%

**p<.04, **p<.01, ***p<.001*

An examination of the parameter estimates reveals the moderation effect of type of brain breaks and gender shows a significant positive relationship between female students' level of engagement in an online class with mental brain breaks. For females, the expected perception of engagement is 1.23 units with 1 unit change in moderation effect and it is a big effect. 10% of the variability is explained in females' perception of engagement after mental breaks. However, for males, it does not matter what type of brain breaks are implemented as they show a similar level of engagement and enjoyment with any type of brain break.

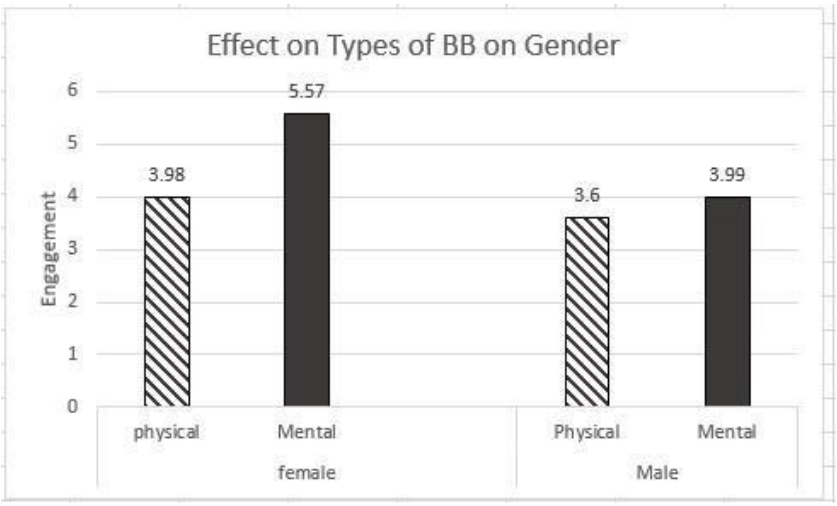

Figure 1. *A Graph Depicting the Effect of Gender on Types of Brain Break*

In summary, the results from this investigation indicate that female students are highly engaged after the mental brain break as graphs (Figure 4) show the highest mean 5.57 of for female and mental brain break, however, female students also showed a positive response in their academic tasks after the physical brain breaks, but this effect was smaller than the mental brain break's effect. So, the moderation is that the difference for females between physical and mental Brain breaks is greater than the difference for males between physical and mental Brain breaks. Although, male students showed the same level of engagement after mental and physical Brain breaks. Interestingly, male students show the same perception of engagement after mental brain breaks as those females show after Physical brain breaks.

Overall female and male students both responded to a higher perception of engagement after mental brain breaks. This summarizes that of the two types of brain breaks used in this classroom-based research, mental Brain breaks achieved the best results in terms of students' engagement in the academic tasks after the brain breaks. This finding presents a slightly distinct perspective to most of the current literature they promote brain breaks of a physically active nature, (Gay, 2013; Hannaford, 2005: Kibbe et. al., 2011; Jensen, 2005), instead of looking at the effects of mental Brain breaks in an online class by gender.

5. RESULTS AND DISCUSSION

Expectancy-value theory (Eccles et al., 1983) describes two factors to assess the student's engagement in the classroom; whether students expect success, and whether they value the academic tasks. However, as I discussed in a literature review, these two components are shaped by some other factors such as students' experience in class, how they feel, and their attitudes towards the tasks (Eccles et al., 1983). Therefore, this current study investigated the effects of brain breaks used by teachers in online classrooms to respond to students' low values to the tasks, and improve engagement (Weslake and Christian, 2015). Additionally, this current study extends the literature by examining the types of brain breaks and the gender effect on the perception of engagement in class, and by examining the moderation effect on the type of brain breaks by gender.

The survey results on a 1 to 5 scale (1 being 'strongly disagree' to 4 being 'strongly agree') show the minimum engagement level is 2 and the maximum engagement level is 5 with a mean of 4.035. The questions specifically focused on 'how they feel', their experience after brain breaks, and how they tend to be more motivated towards their tasks after each brain break. This descriptive analysis shows the positive effects of brain breaks on students' perception of engagement in their academic tasks which corroborates with the Expectancy-value theory (Eccles et al.1983). The breakdown results for females and males indicated that females are highly engaged in academic tasks after Mental brain breaks. Females' responses to engagement after a Physical brain break are also good, but their interest in academic tasks improved after the mental brain break. This indicates that mental Brain breaks are more successful to improve students' engagement in female-majority online classes. Males show the same level of positive response for the physical and Mental brain breaks. As per the Expectancy-value theory (Eccles et al.1983), male students' *attainment and intrusive value* to the tasks remain the same with mental or physical brain breaks (Figure 1). However, females' *attainment and intrusive value* to the tasks improved after the mental brain breaks more than the physical brain breaks. This summarizes that of the two types of brain breaks used in this classroom-based research, Mental brain breaks achieved the best results in terms of students' engagement in the academic tasks after the brain breaks. This finding presents a slightly distinct perspective to most of the current literature they promote brain breaks of a physically active nature, (Gay, 2013; Hannaford, 2005: Kibbe et. al., 2011; Jensen, 2005), instead of looking at the effects of mental brain breaks in an online class by gender. This study contributed to our study that

mental Brain breaks in online classrooms improve the female students' level of engagement with their classroom tasks.

Since this research was conducted in a middle school social studies class, the results from this investigation cannot be generalized to the whole group of middle school students. However, the results indicate that brain breaks, although useful in online classroom settings to improve student engagement, need to be chosen carefully and monitored closely to maximize their potential. While the current investigation of including two types of brain breaks (physical and mental brain breaks) provides good options for an online classroom setting, this research acknowledges that additional studies need to be conducted to further understand the concept and to explore if there is a difference between the genders in online classroom settings.

6. ABOUT THE AUTHOR

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