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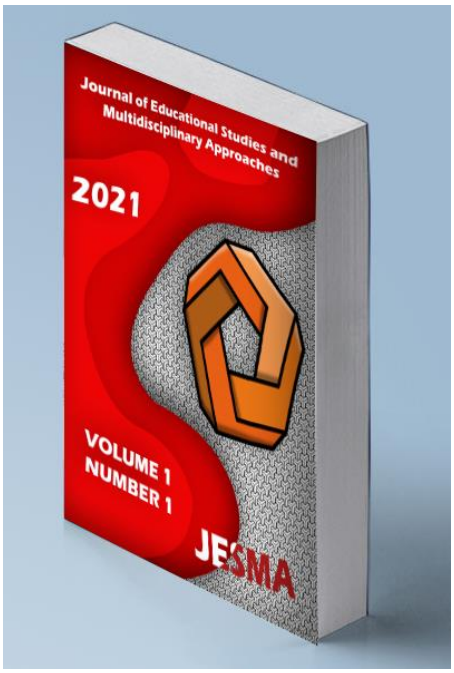

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Effectiveness of a Program Based on Central Cohesion Tasks to Develop Visual attention in Children with Autism Spectrum Disorder

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ABSTRACT

Previous research has indicated that there are deficits in visual attention skills in children with autism spectrum disorder(ASD). The current research aims to verify the effectiveness of a program based on some tasks of central coherence (visual sensory perception and non-verbal communication) in developing visual attention skills (visual communication, visual crossing out, visual tracking, flexibility in transferring visual attention, visual joint attention) for children with ASD. The experimental method was used. The experimental method was used. The sample consisted of 10 children at the four-T Rehabilitation Centre, with age average (8-10) years, and autism disorder level (55-70), divided into two equivalent experimental and control groups. The study tools consisted of the Stanford-Binnet Intelligence Scale to determine the intelligence coefficient, the Gilliam-3 scale for diagnosing ASD, a visual attention scale for children with ASD, and a program based on central coherence tasks. The data were analyzed using appropriate non-parametric statistical methods (Mann-Whitney, Wilcoxon). The results indicated the effectiveness of the central coherence task program in developing visual attention in children with ASD. This study supports the use of central coherence tasks in improving the response of children with ASD to emotional expressions and recommends the continuation of efforts in developing visual attention, which is the main entrance to providing these children with all positive behaviors and skills.

Keywords: Autism Spectrum Disorder, Central Cohesion Tasks, Visual Attention

Introduction

Children with autism spectrum disorder have frequent patterns of behavior, activities, concerns, and inadequacy in interaction and social communication. These symptoms together represent the necessary conditions for diagnosing autism spectrum disorder. although we were unable to determine the direct cause of this disorder with relative weight for neurological causes. However, the exerted efforts with these children alleviate these symptoms, and lead them reaching a mild or moderate level of disorder.

On the basis of the integration of senses in introducing different environmental experiences, there is a consensus on the priority of relative weight in favor of the sense of sight. which is responsible for most of our experiences from the environment and represent an input for visual processing that involves the introduction, storage, restoration, and use of acquired visual thrills, from visual attention through perception and memory to visual thinking. Nevertheless, many studies have observed an obvious deficiency in the stages of visual processing in children with autism spectrum disorder, primarily visual attention, which may be one of the causes that further deepen these children's isolation and social avoidance. Children with autism disorder show a non-conforming visual response early on, indicating hypersensitivity to visual deviation. Therefore, this corresponds to the hypothesis that there is an unusual visual treatment to detect a change in children with autism disorder that may contribute to their intolerance to change (Cléry et al., 2013).

On the other hand, central cohesion theory refers to the ability to form a meaningful macro image of the stimuli around us as opposed to focusing on the details without forming a general link between them. Therefore, it extends on both sides strong central cohesion and reflects the ability to form a macro image and weak central cohesion and reflects the ability to focus on parts without all. This theory includes many functions found in the literature in three areas. These are sensory-visual, verbal-auditory, and non-verbal-communication tasks. Most of these are distributed between tasks that reflect the child's Consider reviewing or deleting this word, depending on the context. Such words are called hedge words as they are used to reduce the certainty or directness of an argument. If used unnecessarily, it can lessen the impact of your message. Use such words selectively. ability to concentrate and familiarize himself with parts and details and indicate a weakness in central cohesion, as opposed to tasks (mostly) that reflect the child's ability to create a holistic picture of environmental effects and indicate the strength of central cohesion. In this regard, children with autism spectrum disorder suffer from visible deficiencies in central cohesion functions, mainly macro functions, where they suffer in the formation or integration of sensory information with exceptional visual efficiency, indicating a weakness in their central cohesion (Nayar, Voyles, Kiorpes & Di Martino,2017, Olu-Lafe,2013., Van Eylen, et al., 2017). When assessing the relationship between autism disorder and total and partial visual treatment in 290 individuals (twins) with autism disorder ranging in age from 8 to 31 years, a fragmentary image test was used to assess and test the total processing. The results indicated a relationship between autism disorder and inadequate total visual treatment in children, adolescents, and adults, which is consistent with the explanation of poor central cohesion in children with autism disorder (Neufeld, et al.,2020)

This research problem has arisen through the cohabitation and field observation of special education centers with visual deficiencies in the visual treatment levels of children with autism. Although approximately 80%–90% of the information the brain receives comes through a sense of sight, this indicates that the human brain tends to favor visual imaging to process information (Amer, &Al-Masri, 2016). However, it has been reported in literature that 65% of children with autism disorder have low visual processing efficiency, which may be attributed to the impact of clinical problems associated with the disorder, such as attention deficiencies and overactive activity (Speirs et al., 2014). In addition, children with autism spectrum disorder suffering from problems related to social behavior, communication, and imagination in addition to many sensory processing disorders, which may appear in overreaction/lack of responsiveness to these triggers, whether visual or auditory (Griffiths & Milne, 2007).

Assessing visual spatial maps within the visual cortex of young people only with autism disorder and noting that some individuals with autism disorder tend not to focus on the target (meaning that their focus is outward-directed focus). It was also found that the extent of the response to external stimuli is strongly associated with stereotypical behaviors and restrictive concerns, which are the main features of autism disorder (Monk, 2013). Research on visual treatment mechanisms in children with autism disorder falls under three frameworks: greater reception area size, high internal noise, and shortage of prediction capabilities. Using the motor visual distinction task, the results indicated that individuals with autism disorder suffer from insufficient mobility sensitivity when the stimulus size is small and that high internal noise was associated with severe behavioral symptoms in children with autism disorder and showed a lack of prediction of movement in children with autism disorder, which was accompanied by unusual patterns of eye movement during the performance of the task. These results reveal deficiencies in visual processing in children with autism disorder during various treatment stages (Park, 2017).

When verifying visual survey patterns in individuals with autism disorder and their normal peers, while processing complex emotional scenes and using the task of reading the mind during movies, both groups demonstrated similar accuracy in identifying feelings and emotions. By examining each excitement through eye movement tracking to verify the visual installation time of places and social scenes, individuals with autism disorder showed a significantly longer installation time but toward non-social scenes (Tang et al., 2019).
On the other hand, normal children tend to combine many aspects of the information to obtain a full and meaningful picture which is known as (Central Coherence). Children with autism spectrum disorder have difficulty in combining information to form knowledge, where they discover the world in a holistic way and focus more on detail than on the overall picture of information. which is known as (weakness of Central Coherence) (EL Shami, 2004, p. 336).

In the same context, the nature of total versus partial processing in children with autism spectrum disorder is an input that is closely related to the idea of central coherence tasks. While analyses revealed lower accuracy and longer reaction time in ASD in the condition with local interference only, when verifying the overall and partial visual processing pattern of the (28) children with autism disorder, and (22) normal children were found to have lower accuracy and longer reaction time in children with autism disorder only in case of partial interference, indicating a lack of overall cognition and partial treatment (Nayar, et al., 2017). In another study, researchers assessed the criteria for operational functions and total and partial visual treatment of relatives with autism disorder in a sample of 113 autistic relatives and 100 normal relatives. Relatives with autism disorder showed a lack of response, cognitive flexibility, and operational functions during daily life. In contrast, they showed no deficiency or partial visual treatment. (Van Eylen, et al., 2017).

The relationship between inadequacies in visual processing, primarily visual attention, and deficiencies in central cohesion functions is evidenced by the high rates of weak central cohesion, visual treatment, joint attention, and verbal communication of patients with autism disorders compared with their normal peers (Morgan, Maybery, & Durkin, 2003). There is also a clear correlation between functional visual anomalies and repetitive stereotypical behaviors (Adamson, O'Hare, & Graham, 2006) and a reverse relation between selective attention and stereotypical behavior in children with autism spectrum disorder (El-Beblawi, Hassan, Sayed, Abdel Ghaffar, 2020).

Considering the previous presentation indicating a lack of visual attention in children with autism spectrum disorder with a clear association with a lack of central cohesion functions, the current research seeks to determine the possibility of developing central cohesion functions, especially those associated with visual orientation, and the extent to which this improvement can be reflected in the levels of visual attention of children with autism spectrum disorder, and to verify the program's

continued effectiveness after the intervention period. The problem of current research can therefore be identified in the following research question:

What is the effectiveness of a program based on some central cohesion functions in developing the visual attention of children with autism spectrum disorder?

Methods and Materials

Research approach

Quantitative research encompasses a range of methods concerned with the systematic investigation of social phenomena, using statistical or numerical data. Therefore, quantitative research involves measurement and assumes that the phenomenon under study can be measured. Quantitative research sets out to gather data using measurements, to analyses this data for trends and relationships and to verify the measurements made (Watson, 2015). There are two broad categories of research design in quantitative research, experimental designs and survey designs, And There are different kinds of measurement, which can be placed in a hierarchy, using a theory of measurement, Generally, measurement in quantitative research is made at the ordinal and interval levels of measurement (Watson, 2015).
In this study based on the experimental approach "Experimental designs an experiment is a study where the researcher can manipulate one variable, the independent variable, and study its effect on a dependent variable" (Watson, 2015). There are many types of experiment, in this study based on the randomized controlled trial experimental design, The experimental method with two groups design of the experimental and control groups was used, with pre, post and follow-up measurements. The independent variable was represented in the program based on central coherence tasks (visual sensory perception and non-verbal communication) and the dependent variable in visual attention (visual communication, visual crossing out, visual tracking, flexibility in conveying visual attention, visual joint attention). The Gilliam-3 scale was used to diagnose the research sample as having autism spectrum disorder, and the use of the intelligence scale was used to verify that the research sample had autism disorder with high functioning. In addition, social level measuring was used to verify that the research sample belongs to close social levels to exclude any social differences in the research results.

Sampling

Quantitative research questions lend to either probability or non-probability sampling methods, The current research relied on a non-probability sampling method, specifically purposive sampling, Purposive sampling Uses sampling techniques that rely on the researcher's judgment for selecting persons. These techniques include maximum variation sampling, expert sampling, and typical case sampling (Berndt, 2020).
The simplest form non-probability-controlled trial requires at least two groups of participants: a treatment (also referred to as experimental or intervention) group and a control group. The treatment group receives the treatment being tested and the control group does not. However, the control group should be treated in exactly the same way as the treatment group, or as closely to this as is possible, except that they do not receive the treatment. The initial sample consisted of 96 children with autism spectrum disorder from six centers. The sample was selected in several steps. Children with moderate autism spectrum disorder were excluded; children with a low intelligence coefficient (within the limits of Intellectual disability) were excluded, and children were limited to 8-10 years of age, suitable to accommodate training in central cohesion tasks. After this selection process, eligible children were selected on the visual attention scale. Thus, the primary study sample consisted of 10 children with autism spectrum disorder who had deficiency in the levels of visual attention and ranged in age between 810 years, and the autism index ranged between (55-70) on the Gilliam-3 scale.

There are many possible methods of allocating individuals who have agreed to participate in the non-randomized controlled trial to either the treatment group or the control group. Randomization is used to minimize bias in allocating individuals to the two groups, The 10 children were divided into two equal groups, experimental and control, each of which consisted of 5 children, 3 males and 2 females.

Table 1. The results of the Mann– Whitney test to indicate the differences between the mean ranks of the scores of the two groups in the pre-measurement variables of intelligence, age, autism disorder, and visual attention

Variants	Group	n	Average calculation	Standard deviation	Average grades	Total grades	U	Z	signifi cance	significa nce
Intellige nce	Experimenta l	5	88.2	2.588	6.70	33.50	6.5	1.2 73	0.212	insignific ant
	Control	5	88	1.581	4,30	21,50				
Lifetime	Experimenta l	5	8.8	0.836	6.60	33.00	7.0	1.1 67	0.310	insignific ant
	Control	5	8.4	0.547	4.40	22.00				
Social Level	Experimenta l	5	31.8	3.030	5.20	26.00	11.0	.31 6	0.841	insignific ant
	Control	5	32.2	2.810	5.80	29.00				
Autism disorder	Experimenta l	5	34.6	1.341	6.20	31.00	9.0	0.7 45	0.548	insignific ant
	Control	5	34	2.000	4.80	24.00				
Visual Attentio n	Experimenta l	5	28.0	2.236	5.10	25.50	10.5	0.4 23	0.960	insignific ant
	Control	5	28.6	2.509	5.90	29.50				

Table 1. shows that there were no statistically significant differences indicating the parity of the two research groups in IQ variables, age, social level, autism disorder, and visual attention in the pre-measurement. Therefore, the improvement in the post-measurement is due to the central cohesion program.

Materials/tools

Stanford Binet Scale of Intelligence (Arabic version) Abu al-Nil, Taha, Abdel Samie, (2011)
The Stanford-Binet Intelligence Scale (Fifth edition) was used to verify that the research sample doesn't suffer from any intellectually disability. This scale was applied individually, and it consists of 10 sub-scales, distributed over two main domains, verbal and non-verbal domain and the verbal domain, to measure five main factors in each of the previous two domains: fluid reasoning, knowledge, quantitative reasoning, and visual-spatial processing. Working memory. The application of the scale results in three intelligence coefficients: the total intelligence coefficient, the non-verbal intelligence coefficient, and the verbal intelligence coefficient.

Gilliam-3 scale(Arabic version) El-Beblawi, Hassan, Abdel Moneim,(2022).

The scale was used to diagnose the research sample and determine the level of severity of autism spectrum disorder, this tool was used. The first edition of this scale was printed in 1995, the second edition in 2006, and the third (current) edition in 2014. The Gilliam Autism Rating Scale-Third Edition (GARS-3) consists of 6 subscales across 58 items. These include specific/repetitive behaviors, social interaction, social communication, emotional responses, cognitive style, and inappropriate speech. The scale is graded from (0-3), where (0) does not apply at all, (1) applies rarely, (2) applies slightly, and (3) applies often. The scale provides a determination of the severity of the disorder.

the socioeconomic and cultural level of the Egyptian family Scale (Hassan, 2018)

.

The scale was used to recognize the social, economic, and cultural background of the families of the research sample, this scale was used. The measurement was designed to review the social, economic, and cultural level of the Egyptian family in light of the current changes, on a sample of Egyptian families amounting to 701 families, which varied between urban (rural and city) governorates in Upper Egypt and coastal areas in the north of Egypt. The most important variables identified to build a predictive equation for this level education level, job or profession, income level, and lifestyle, with a quantitative estimate for each level.

Visual Attention Scale (Author's preparation):

The visual attention scale was prepared and used to diagnose children with ASD and achieve the objective of the current study. The correlation factor between the degree of each situation and visual attention was calculated and ranged from 0.969 to 0.492. In general, the term statistical function was 0.01, excluding (2) statistically non-statistical terms.

Validity

The scale's validity was examined by:

a) Construction validity: The scale items and the measure's procedural definitions were derived considering the analysis of previous theories and metrics to benefit the construction validity and composition.

b) Test credibility:
The Optical Spatial Treatment Scale was used for children with autism disorder (Abdul Fatah & Yusuf, 2016) and applied to the same sample, and its coefficient values with Pearson (0.889) and Spearman (0.483) were 0.01.

Reliability

The constant has been calculated in several ways:

a) The alpha Cronbach method: The optical processing scale constant coefficients were calculated using Cronbach's alpha method of 0.979, reflecting an appropriate degree of stability.

b) Retest method: The scale was applied to the same sample after a month, and the Pearson correlation coefficient (was 0.993).

The Final form of the scale

The final visual attention scale comprises (13) graphic performance positions directly applied to the child, and each phrase has three alternatives. (Correct Response - Partially Assisted Response - Total Assisted Response) in order and quantitative weight (3-2-1), thus ranging between 13 -39 degrees of the quantitative scale. The high degree indicates a high level of visual attention and vice versa, and is based on the preceding presentation of the scale's psychometric properties. Therefore, it can be argued that these procedures require rigorous use.

A program based on central cohesion functions (Author's preparation)

The program's construction involved the identification of its objectives, the foundations on which it relied, its significance statement, and the strategies and techniques used therein, as follows:

a) The program's objectives:

Overall objective: To develop visual attention in children with autism spectrum disorder through a program based on central cohesion functions.

Sub-objectives: To ensure the objectives of the independent variable, the program is based on central cohesion

- Improve visual perception tasks
- Improving non-verbal communication functions.

b) Principles on which the program was based:

- A relationship of familiarity exists between the researcher and the sample.
- The program's content is suited to the characteristics and needs of children with autism disorder.
- The program's activities are primarily visual and natural.
- Diversification in both material and moral reinforcement methods.
- The program's activities should be based on individual work and collective activities.
- Gradually moving from simple to complex skills.
- Learned behaviors have practical value and usefulness in children's lives.
- Continue training for sufficient time until the child's behavior is discovered.
- Use up to 70% for sometimes required performance, not 100%.
- Ensure that the impact of education is transmitted from the training environment to the home through homework.

c) Importance of the program:

There is no doubt that information processing goes through many complex knowledge processes, and visual processing occupies a significant space. Approximately 90% of our information is generated through the sense of sight. as well as the characteristics of children with autism disorder. Most of them may suffer from visual sensory problems that may result in an increase or lack of visual response, adding value to the intervention through this program to develop the visual attention of autism disorders.

d) Procedural limits of the program:

The research sample was selected from children with autism spectrum disorder at the 4-T Center in the Giza Governorate. The program was implemented with a total of (20) sessions, at the rate of (3) sessions per week. The duration of the session ranged from (10-20) minutes for each child individually, according to the content of the session, with a total time for each session ranging between (50-100 minutes) during the months of January and February 2021.

e) Techniques and methods used in the program:

The most important strategies and techniques used in the current program were: individualizing education, directing attention, modeling, role playing, reinforcement, homework, task analysis, and following instructions.

f) Program implementation:

The program sessions were implemented by training on tasks (16 tasks) of central coherence, focusing on visual sensory perception. 11 of these tasks allowed the child, through training on them, to reach an appropriate level in all visual processing skills. For example, in the repetitive forms task, the child is asked to complete an array of geometric shapes with specific colors to achieve the same rule. This requires complex visual processing that includes the skills of attention, perception, and remembering, leading to visual thinking about the rules that govern the pattern and its completion. Additionally, four additional tasks relate to non-verbal communication. Through training in the tasks, the child can reach an appropriate level in the skills of visual perception and memory. For example, in the task of processing the full face, the child is asked to collect the parts of the face that are divided into small parts to form the face. This task requires children to perform complex visual processing that includes whole face recognition and memory skills.

g) Program Evaluation:

The program was evaluated through the following: pre-evaluation: applying the visual processing scale before applying the program, structural evaluation: at the end of each stage, post- and follow-up evaluation: applying the visual processing scale after implementing the program and one month after the end of the program.

Ethical Considerations

Research ethics consists of a core set of scientific norms, developed over time and institutionalized in the international research community. The truth norm is indispensable to all scientific activity: The search for truth, commitment to truth, integrity, and honesty are preconditions for quality and reliability in research. Research is also based on methodological norms, such as factuality, accuracy, transparency, and accountability (Becin, & Saginur, 2016).

The researcher has responsibilities towards all children involved in or affected by the research. This made him highly respect the human dignity of the participants and took into account their personal safety and well-being. Participation in research, as a rule, is also based on information and consent. But in this study, when it was difficult for the participating children to be able to provide consent, the researcher took the responsibility of protecting their freedoms, rights and human dignity. and also get it from parents or. Especially since the participants in the research are children with autism spectrum disorder, so it was necessary to obtain the consent of the parents for the child's participation in the rehabilitation program.

With full clarification of the nature and duration of the training program, the place of training, the number of training sessions, and a full explanation of the procedures followed to ensure the confidentiality and privacy of the child, and that these sessions were not subject to filming, with the existing opportunity to withdraw from training at any time. Quantitative data were collected through the Center’s childcare providers, with confirmation that the names of the participants were anonymized and inferred from the first letter of each participant’s name. There was freedom in the possibility of participants completing or withdrawing during the experiment, and participation in the research did not result in minimal risks to children.

Findings

First Hypothesis

There were statistically significant differences between the mean scores of the experimental group in the pre- and post-measurements in visual attention in favor of the post-measurement.

Table 1. Wilcoxon results in differences between the means of the grades of pre- and post-measurements of the experimental group in visual attention

Dimensions	Test	Monotonic function	n	Average rank	Total rank	z value	significance	rprb	effect size
visual attention	Pre	Negative grades	0	300.	1500.	2.032	0.05	1.0	very large
	Post	Positive grades	5	000.	000.				
		Equality	0						
		Total	5						

It is clear from Table (2) that the value of (z) amounted to (2.032), which is statistically significant at the level of (0.05), which indicates that there are differences between the mean ranks of the scores of the children of the experimental group in the pre and post measurements in visual attention in favor of the post measurement, and that the coefficient (rprb) reached (1.0), which indicates that the effect size of the program is very large.

Second hypothesis

There were statistically significant differences between the mean scores of the experimental and control groups by telemetry in visual attention in favor of the experimental group.

Table 2. Mann –Whitney results in differences between the two groups' grade averages experimental and control in visual attention by dimensional measurement

Variants	Group	n	Average rank	Total rank	z value	significance	rprb	effect size
visual attention	Experimental	5	8.00	40.00	2.677	0.01	1.0	very large
	Control	5	3.00.	15.00				

It is clear from Table (3) that the value of (z) amounted to (2.677), which is statistically significant at the level (0.01). This indicates that there are differences between the mean ranks of the scores of the children of the experimental and control groups in the two post-measurements in visual attention in favor of the experimental group. In addition, the coefficient ((rprb reached (1.0), which indicates that the effect of the program is significant.

Third hypothesis:

There were no statistically significant differences between the mean scores of the experimental group in the post- and follow-up measurements of visual attention.

Table *4.* Wilcoxon results in the differences between the mean scores of the post- and follow-up for the experimental group in visual attention

dimensions	Test	Monotonic function	n	Average rank	Total rank	z value	significance
visual attention	Pre	Negative grades	2	1.75	3.50	0.272	insignificant
		Positive grades	1	2.50	2.50		
			2				
			5				

Equality	
Total	

It is clear from Table (4) that the value of (z) amounted to (0.272), which is not statistically significant. This indicates that there were no statistically significant differences between the mean scores of the experimental group children in the post- and follow-up measurements in visual attention. Consequently, this indicates the maintenance of the level of improvement in visual attention of the experimental group.

Discussion

The findings of the current research point toward the effectiveness of the program based on central coherence tasks in visual sensory perception and non-verbal communication; developing visual attention skills (visual communication, visual crossing out, visual tracking, flexibility in transferring visual attention, visual joint attention) in children with autism spectrum disorder; and the continuation of the positive effect of the program after the end of the intervention for a month.

This research findings consistent with several studies aimed at improving the visual attention of children with autism spectrum disorder, such as Al-Farra (2012) noted the effectiveness of a computerized program in improving visual attention. And Al-Ghalilat Study (2018) noted the effectiveness of a program based on symbolic enhancement in the development of audiovisual attention skills. Abdulhameed, & Younis (2018) noted the effectiveness of an animation-based program in developing visual attention, and Abdul Ghaffar (2020) indicated the effectiveness of an optical-based program in improving selective attention and its impact on stereotypical behavior.
The improvement in the experimental group may be due to the activities, content, and strategies of the program, as it relied on central cohesion tasks in its first dimension, sensory– visual perception. The third dimension, which is non-verbal communication, consisted of four tasks, all of which allowed the child, through training, to reach an appropriate level in visual perception and memory skills. Hence, the passage and visual performance of the child through these tasks reflected their positive effects in improving the levels and visual processing skills intended to be improved in children with autism disorder.

Based on the fact that the nature of cognitive processes is inferred through the different performances that can be observed and measured, the clear deficiency in visual attention appears, as the attention of children with autism disorder is abnormal, and what is normal for them is their ability to sustain their attention for long periods of the things that interest them. They suffer from deficiencies in other forms of attention, the first of which is the difficulty in directing their attention toward the source of the stimulus and in paying attention to something in its complete form (EL Shami, 2004, p. 295).
Visual communication is one of the most significant non-verbal communication problems in children with autism spectrum disorder. These children cannot communicate with their surroundings, which negatively reflects their response to social interaction and emotional exchange (Dawson, Hill, Spencer, Galpert, & Watson, 1990). They also show a lack of attention to the communication partner, the ability to transform their eyes between people and objects, or even follow their eyes or gestures to share interests and experiences (Meindl & Cannella-Malone, 2011).

To overcome these attention problems, the central coherence tasks were appropriately employed during the intervention sessions by employing the skill of visual search for a stimulus in a specific color, larger or smaller size, or a specific shape. Here, the child passes through many visual attention skills, such as maintaining eye contact, visual crossover of stimuli, visual tracking of these shapes and their connection, and access to the joint visual attention of the trainer in the process of visual search for the stimulus until the completion of the connection.

Strengths and Limitations

1. The research focused on some central coherence tasks related to visual processing, and not all central coherence tasks.
2. The research determined the age of the sample children from 8 to 10 years ignoring, older and younger children.
3. The study sample consisted of only 10 children with autism spectrum disorder who met the characteristics of the sample, and the researcher couldn't reach a larger number of individuals due to the scarcity of these characteristics combined together , in the children with ASD .
4. The individuals of the sample were selected intentionally, to consider the homogeneity, which may affect the reliability of the results.
5. The sample children are from one governorate only, which may limit the possibility of generalizing the results to all children in all regions.
6. The research relied on measures that depend on the examiner's personal evaluation, and this may affect the reliability of the results due to the possible occurrence of measurement error.

Conclusion

In light of previous research indicating deficiencies in visual attention skills in children with autism spectrum disorder, the current research concluded that training on some central coherence tasks (visual perception, non-verbal communication) enhanced the development of visual attention skills (visual communication, visual crossing out) among children with autism spectrum disorder. The current research concludes the possibility of developing different visual attention skills through the use of training based on the employment of attractive visual stimuli for children with autism spectrum disorder. The research continues to accept many contributions about the employment of other visual stimuli in this regard. Considering these results, some recommendations and researches can be developed.

Recommendations and suggested research

- Using of central cohesion functions (verbal audio communication) in developing hearing therapy in children with autism spectrum disorder.
- Using central cohesion functions to improve responsiveness to emotional expressions in children with autism spectrum disorder
- Using modern technology to develop visual attention skills for autism disorders.
- Comparison of visual attention skills of low- and high-functioning individuals with autism disorder
- Comparison of total and partial central cohesion functions in low- and high-functioning individuals with autism disorder
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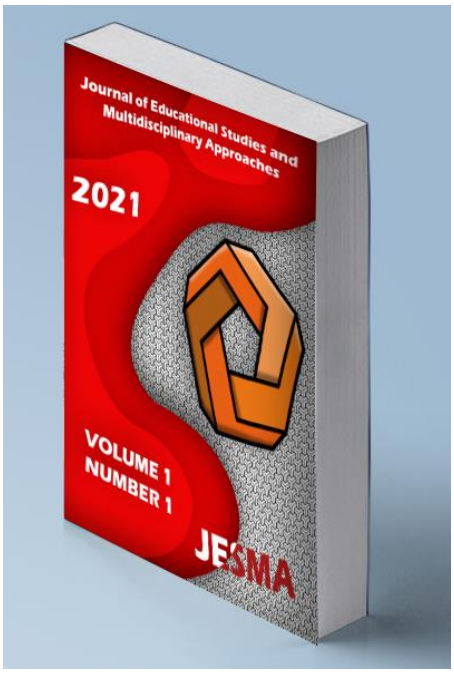

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Mathematics Teachers and Pre-service Teachers' Opinions on Distance Education

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Mathematics Teachers and Pre-service Teachers' Opinions on Distance Education

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ABSTRACT

School closures during the COVID-19 pandemic have made education dependent on online teaching. It turned into an unprecedented experience for teachers and students. Therefore, this study examines the views of mathematics teachers and pre-service mathematics teachers on distance education practices. The data of the study were collected through a written and online questionnaire to thirty-seven mathematics teachers working in secondary/high schools in Turkey and final year pre-service mathematics teachers continuing their education in universities. The data were analyzed through descriptive and content analyses. At the end of the study, pre-service teachers expressed a high level of positive opinion on distance education practices. Teachers, on the other hand, expressed approximately equal numbers of positive and negative opinions on distance education practices. In addition, participants characterized distance education practices in similar categories as negative. These categories include the inadequacy of technological infrastructure, the inadequacy of teacher– student interaction, and the impossibility of access. Similarly, participants expressed positive opinions in different categories. These categories were easy to access, repeatability, and economy. In addition, students and parents expressed concerns about the functionality of distance education applications in mathematics education, such as insecurity, family unrest, and financial problems.

Keywords: Distance education, mathematics teaching, mathematics teacher, mathematics pre-service teacher, COVID-19.

Introduction

The latest developments in technology have sped up education for individuals and spread distance education rapidly. Today, the changing environments and conditions also encourage educational institutions to seek additional platforms to continue to provide quality education. Distance learning is a commonly used method of providing education by using interconnected, network-like technologies. technology will play a primary role in the future of the education sector. When education is the matter of discussion, teachers, beyond building knowledge, are the main entities of the academy for which they are responsible , and as it is in each education, teacher– student interaction should also be effective in distance education.

Distance education appears before us as an educational content that achieves the separation of teachers and students physically from each other in terms of their main elements (Berg & Simonson, 2002). Distance education is defined as providing students with any teaching content and related support services online in cases where physical education is missing (Pena-Bandalaria, 2009). In parallel to technological developments, the increasing internet infrastructure possibilities also eliminate the place limitations in individuals' reaching knowledge (Ergüney, 2015). Therefore, like many other areas, education has been affected by changes and transformations in the world. From this perspective, distance education, which decreases teaching place limitations in the field of education and facilitates accessibility everywhere, is gradually becoming more common (Haymana & Dağhan, 2020) and a settled part of the education world together with the development tendencies that it shows (Berg & Simonson, 2002).

Together with the widespread use of the Internet, the existence of institutions such as Coursera, Edx, Udacity, Khan Academy, Futurelearn, Openstudy, Codeacademy, Openlearning, NPTEL, Udemy, and ALISON providing open-sourced MOOC distance education services that provide individuals with opportunities for learning and education in digital environments has been known since 2011 (Ergüney, 2015). Online teaching and learning has been commonly used in higher education for nearly for twenty years. To support online interactions such as discussions, evaluation, sharing, and interaction, various tools and platforms are being developed and tested and reaching a relatively high level of acceptance (Mues & Howar, 2020). However, adoption is taking place slowly in primary and secondary school education. The COVID-16 pandemic, which developed unexpectedly and affected life rapidly, is affecting education, particularly teacher education, in various ways. Because of the closing of universities and schools, teachers and students had to adapt rapidly to distance education. Teachers, many of whom had never taught online before, had to redesign their programs to support their students fully online. In this case, the pedagogical approach to teaching and learning involved a complete change and the use of a range of new technologies (Gürley, 2018). Moreover, the need to create learning environments for pre-service teachers made it necessary to change not only students' expectations but also the requirements of teacher education and both universities and schools' decisions, choices, and adaptations in order to meet the conditions in which they are (Assunção-Flores & Gago, 2020). This rapid, unexpected, and compulsory transition from face-to-face to distance education has brought opportunities that require examination in addition to a series of difficulties and limitations. This form of teaching, defined in the current literature as "emergency distance teaching" (Bozkurt & Sharma, 2020) or "emergency e-learning" (Murphy, 2020), has revealed the existence of a knowledge gap in teacher education and difficulties related to poor online teaching infrastructure in a complicated environment at home (Zhang et al., 2020). In addition to these difficulties, it was understood that there were problems related to mentorship and lack of support (Smith, Kahlke & Judd, 2020) and problems related to teachers' competencies in using digital teaching materials (Huber & Helm, 2020).

In previous studies in this field on teachers' developments and problems, in addition to explanations about how institutions and stakeholders had adapted to distance learning created due to the COVID-19 pandemic (Hasan & Bao, 2020; Assunção-Flores & Gago, 2020; Quezada, Talbot & Quezada-Parker, 2020; Zhang et al., 2020), some explanations were also made in relation to education strategies and innovation experiences (Ferdig et al., 2020). While digital education is an industry-wide priority, the pandemic has required the adoption of new approaches (Lockee, 2021). To prevent this from becoming

a state of technology that dictates pedagogy or seeks impossible requirements, an iterative process has been developed. Simultaneous fully online teaching was also considered for courses, but asynchronous courses were preferred (Daniel, 2020). While various approaches have been tried, a flexible online, offline, and hybrid approach known as HyFlex has allowed students to attend classes on campus or online, and both groups learn together simultaneously (Beatty, 2019). Although the explanations about how the teachers and the pre-service teachers responded to the transition from face-to-face teaching to online teaching are valid, it is necessary to determine and explain in detail the difficulties they had in relation to this matter.

Since it provides the opportunity to study courses at any time when students and teachers are convenient and at any place with Internet access, distance education creates advantages for students and teachers. The fact that students are less disturbed during distance learning compared to classroom learning, they do not need to feel embarrassed because of a mistake which they make in front of their friends, they do not feel stressed, and they undertake the responsibility of time management by planning when and what to study are mentioned among its benefits for students (Katane, Kristovska & Katans, 2015). Although flexible distance education imposes too many responsibilities on students, it allows students to become independent and study without needing any supervision by another person within the course of time. For students avoiding undertaking responsibilities, distance education becomes a disadvantage. Because students are not face-to-face in the classroom environment, there appears to be a loss of interaction between students. In-class interactions help students develop critical thinking and problem-solving skills (Vlasenko & Bozhok, 2014). Because some of this interaction occurs between students in distance education, a decrease can be seen in critical thinking and problem-solving skills.

In the research studies, Acar and Peker (2022) investigated the mathematics teachers' opinions about live (synchronic) distance education; Aknc and Pişkin-Tunç (2021) investigated the problems that the secondary school mathematics pre-service teachers encountered and proposed some suggestions; Aydoğdu, Iskenderoğlu and Konyalihatipoğlu (2021) investigated the mathematics teachers' teaching experiences in the mathematics teaching practice performed via distance live courses; Coşkun-Simşek et al. (2022) examined the teachers' knowledge and awareness levels in relation to the process of distance education and their opinions about their self-efficacies and practices; Ersen and Yumak (2021) examined the primary school mathematics pre-service teachers' opinions about distance education; Korkmaz (2021) examined the pre-service teachers' opinions and attitudes about the Google Classroom digital platform used in the process of distance education and distance education; Ozdemir-Baki and Celik (2021) investigated the secondary school mathematics teachers' problems in the spring semester, the precautions that they took in the fall semester to solve these problems, the methods, the techniques, and the educational contents that they used; Sen (2021) investigated the secondary school mathematics pre-service teachers' suggestions in relation to the evaluation and the development of TRT EBA TV mathematics course programs; Tican and Toksoy-Gökoğlu (2021) investigated the secondary school mathematics teachers' opinions about distance education mathematics subject.

It is important to gain more knowledge about the potential and use of productive distance teaching and learning tools. Therefore, it is essential to go beyond emergency online practices and develop quality online teaching and learning resulting from careful teaching design and planning (Hodges et al., 2020). There is support through the comparison of course level factors that students can learn online as much as they learn face-to-face. Bernard et al. (2004), in their meta-analysis of 232 online learning studies, concluded that there was no significant difference between online and face-to-face learning. Driscoll et al. (2012) obtained similar results in online assessment and evaluation. Numerous studies in the literature (Ashby, Sadera & McNary, 2011; Bowen et al., 2014; Brown, 2012; Cavanaugh & Jacquemin, 2015; Dell, Low & Wilker, 2010; Enriquez, 2010; Holmes & Reid, 2017; Jones & Long, 2013; Lyke & Frank, 2012; McCutcheon et al., 2015; Mollenkopf et al., 2017; Nemetz, Eager & Limpaphayom, 2017; Stocker, 2018; Wagner, Garippo & Lovaas, 2011; Wu, 2015; Zhao et al., 2005) support that face-to-face education and online education do not have a positive or negative effect on outcomes. Therefore, a consensus has been expressed that there is little difference in student performance between instructional environments for courses in which both environments are available (Pattnaik, Nath & Nath, 2023).

Focusing on how the current context forces many teacher education programs to adapt to an online format might provide a wide understanding of the adopted practices. However, it is necessary to make these practices effective. For this reason, it will be useful to provide knowledge for future practices and determine the precautions that need to be taken in relation to the education of teachers and pre-service teachers. This period of change not only provides a point of view based on evidence about what is useful and what is not useful, but it also, perhaps most importantly, puts forward the necessity of understanding the characteristics, processes, consequences, and effects of online practices. Recent studies have shown that both individual and institutional factors affect teachers' capacity to adopt new digital practices (Ertmer & Ottenbreit-Leftwich, 2010; Howard, 2019). For this reason, to be able to clearly reveal teachers and pre-service teachers' situations, it is necessary to take their opinions about distance education into consideration. This approach provides a clearer understanding of what support is needed to support the process of distance education in terms of determining the agenda of education and the school. Thanks to the presence of such factors as the possibility of benefiting from online educational activities in a desired period of time by decreasing their disadvantage of being far from the education created by the location and the place in which a person is and the flexibility that it provides for students and teachers, its use is gradually increasing in many educational institutions and institutional areas day by day. With the recent COVID-19 crisis, distance education has come to the fore as a necessity, making it inevitable and undesirable to study the effectiveness of this type of education and the changes it brings to education systems. That the topic of online learning and teaching is excluded from the teacher training program and many teachers have limited knowledge and experience about online learning and teaching makes us consider that teachers and pre-service teachers are unknowledgeable about online pedagogies or how to support online learning (McAllister & Graham, 2016). For this reason, this study aims to investigate the effectiveness of distance education.

There are various previous studies on teachers' distance learning and teaching. It was revealed in Turkey that the teachers had a moderate level of technological readiness, and there was not a significant difference between the teachers in terms of readiness to technology according to their ages and branches, but there was a significant difference between the levels of readiness to technology and gender (Summak, Bağlıbel & Samancıoğlu, 2010). Moreover, a study found that teachers' motivation and education were the most important factors in e-learning (Hung, 2016). It is important to determine the areas in which teachers' knowledge should be developed, the difficulties encountered in the application process, and the opinions related to the use of digital online technologies. The questions related to online teaching might include how open education will be provided, how communication will be established and how learning will be evaluated (Gürley, 2018).

In the research conducted by Cakn and Kürekçi-Akyavuz (2020), one of the studies conducted recently on distance education in Turkey stated that teachers have communication problems with parents and students in distance education. Bayburtlu (2020) stated that the teachers could not attend the live courses because some of their students did not have the infrastructure, some of the parents were uninterested in this process, and they did not follow the courses while their students were on the computer. By citing these problems, it has been tried to define that both the quantity and quality of distance and face-to-face education are important (Can, 2020). It has been stated that the problems related to distance education in Turkey stand out as technical inadequacy, lack of information, lack of communication, indifference of teachers, and lack of planning (Cakın & Külekçi-Akyavuz, 2020; Bakırcı, Doğdu & Artun, 2021; Arslan & Sumuer, 2020). It was observed that teachers expressed positive opinions on the use of technology in mathematics courses (Boz & Özerbaş, 2020; Sarı & Akbaba-Altun, 2015). Considering the literature summarised above, it is known that distance learning and teaching teachers, especially mathematics teachers, have a medium level of technology readiness, and that there are no significant differences in technology readiness among teachers according to their age and sector, but there is a significant difference between levels of technology readiness.

In this study, starting from mathematics teachers' experiences in the period of rapid transition to online teaching, particularly during the COVID-19 pandemic, their opinions about the practices of distance education in the teaching of mathematics (its positive and negative effects on mathematics education) were investigated. Hence, it is considered that these experiences will contribute to schools and

educators' preparation for online and hybrid learning in the future. The presence of online teaching forms the framework of this study, and the investigations are being undertaken from this perspective. Starting from mathematics teachers' opinions, answers are being sought for the following research problems:

1. What are the mathematics pre-service teachers' positive and negative opinions on distance education practices in mathematics education?

2. What are the mathematics teachers' positive and negative opinions on distance education practices in mathematics education?

3. What are the mathematics pre-service teachers' expressions about students' and their parents' worries related to the functionality of distance education practices in mathematics education?

4. What are the mathematics teachers' expressions about the students' and their parents' worries related to the functionality of distance education practices in mathematics education?

Methods and Materials

The mathematics teachers' and pre-service teachers' opinions on distance education in teaching mathematics were analyzed via qualitative analysis methods. In this respect, the design of the study was determined to be a case study.

Case study is one of the techniques used commonly in educational sciences and is used to investigate a certain event within its own systematic in detail (Creswell, 2009; Merriam, 2009). In a case study, an event or phenomenon is examined holistically in detail by taking the perspective of relevant participants (Yıldırım & Simşek, 2005). A case study explains an event to a reader in a real manner and in the way it was lived by providing stable and useful meanings (Gall, Gall & Borg, 2007). In this respect, in this case study related to distance education practices, the teachers' and the pre-service teachers' opinions were determined as a case and they tried to be explained.

Sampling

In this study, the participants' positive or negative opinions about distance education in mathematics education and their expressions about the students' and their parents' worries related to the functionality of distance education practices in mathematics education were analyzed under different dimensions. With this aim, the participants of the study were determined from among the teachers and pre-service teachers taking education at universities present in the cities of Konya, Alanya, Istanbul, and Bursa in the three geographical regions (Marmara, Central Anatolia and Mediterranean) taken within the scope of the study during the fall semester of the 2021–2022 academic year2021–2022. The researchers first analyzed the questions developed for data collection with their own students and teachers in postgraduate education. This was a preliminary pilot study. Following the corrections made in this process, the questions were given their final version by subjecting them to expert opinion. In this scope, 90 mathematics pre-service teachers who were willing to participate in the study and 37 mathematics teachers who were currently working in the same region participated in the study.

Three open-ended questions prepared by the researchers with the aim of taking the participants' mathematics teachers' and mathematics pre-service teachers' opinions were addressed to the participants. They were asked to provide detailed answers to these questions. These questions were as follows:

1. What are your positive opinions on the practices of distance education?
2. What are your negative opinions on the practices of distance education?
3. What are your students' and their parents' worry about the functionality of distance education practices?

There was no time limit during the answering process. The answers given to these questions were collected via pen and paper in written form in some cities and with Google Forms in the electronic environment in some other cities. In the analysis and interpretation of the data, including the answers

that the participants gave to the three open-ended questions given above and recorded in written and electronic environments, the content analysis and descriptive analysis methods, two of the qualitative data analysis methods, were used.

For the first and second research problems, the content analysis method was applied. Content analysis has various definitions. While content analysis is interpreted by Holsti (1968; Cited by Berg, 2004) as a technique used to make deductions by systematically and objectively determining certain characteristics of messages, it is defined by Bogdan and Biklen (2007) as a coding procedure and a data interpretation process. Content analysis covers the examination of content by referring to the meanings, contexts, and intentions included in messages (Prasad, 2008). In content analysis, researchers examine the frequency of words and main themes through systematic observations and analyses and determine the content and characteristics of knowledge embedded in the text (Hair et al., 2003: 126). The data obtained in the content analysis are conceptualized first, then arranged logically according to these concepts, and finally, the themes explaining the data are determined by starting from this arrangement (Yıldırım & Simşek, 2005: 227). The stages of coding the data, coding the themes, and arrangement of the data according to the codes and themes are realized, and the analysis is completed.

In content analysis, the research data gathered from the first two open-ended questions were analyzed by coding the data, coding the themes, and organizing and defining the data according to the themes. At the stage of coding the data, first of all, the participants were asked questions. The answers they gave were read many times, and the dimensions important for the research were determined. Then, the expressions obtained because of the examinations were examined and found to be meaningful. It has been divided into sections, and we have tried to understand what each section means conceptually. During the coding of the themes, these sections, which constitute a meaningful whole in themselves and contain the answers related to the research, were coded. Then, the codes that were similar were brought together in these codes. In the meantime, some codes that were not suitable for the research were removed, and some codes that were suitable for the purpose were added when necessary. Thus, themes at the most general level and sub-themes under these themes were revealed. Codes were organized and defined under these subthemes. The data were then organized and described according to emerging codes and themes (Yıldırım & Simşek, 2005: 228-239). In this study, the first two open-ended questions that provided the research data formed the two themes at the most general level of this part of the research. For these two themes obtained from the research data, three different sub-themes were determined as positive thought, negative thought, and neutral. Then, codes were determined using these sub-themes, and the findings of these codes and themes were reported. With the interpretation of the findings, we attempted to reveal the thoughts of the mathematics teachers and pre-service teachers participating in the research on distance education.

Among the research problems, the qualitative data obtained within the scope of the third and last research problem were analyzed using the descriptive analysis method. The aim of descriptive analysis is to organize the findings and present them to the reader in an interpreted form. In this analysis method, data are systematically and clearly described. The results obtained can be related to themes, interpreted, and predicted for the future (Yıldırım & Simşek, 2005: 224). The research data obtained from the answers given to the last research problem within the scope of the research were analyzed by creating a framework, processing the data according to the thematic framework, and defining and interpreting the findings.

At the stage of establishing a framework for descriptive analysis, the third research problem established the most general level framework for data analysis. At the stage of processing the data according to the thematic framework, the data for the third research problem are under 6 different themes: general worries, distrustfulness, domestic unrest, financial difficulties, fruitlessness, and lack of knowledge. At the stage of defining and interpreting the findings, the data obtained according to the determined themes were read and organized. The organized data were then defined and the findings were interpreted through these themes. Finally, research findings were supported by direct quotations where appropriate. Thus, we attempted to reveal the concerns and thoughts of the participants of the research.

The research data were analyzed using categorical analysis and frequency analysis using Microsoft Excel. Due to the need for more than one coder in the process of analyzing complex qualitative datasets and the large number of datasets, the data were stored and encrypted in a cloud. The coding process was then detailed during the analysis process using the Nvivo software. In these analyses, the qualitative

data in written form obtained within the aim of the research were reduced to numbers by going through the processes required by the content and descriptive analysis described above. With the aim of achieving validity and reliability in relation to the process of data collection and analysis, the coding was compared by the researchers independently and then shared codes and sub-themes were determined in the meetings held. According to Miles and Huberman (1994), when two researchers code using the same dataset, definitions become clearer. In this way, it is possible to reach a common understanding of what coding means and which piece of data belongs to which code. During the analysis process, the inter-coder reliability coefficient was 86%. This was found to be in line with the criteria established by Miles and Huberman (1994). Moreover, the technique of participant confirmation was also beneficial. Thus, we tried to ensure the reliability of the research and to reduce its bias. The validity and reliability of this qualitative research was ensured by considering the credibility, transferability, consistency, and confirmability strategies (Yıldırım and Simşek, 2005: 264-272).

Ethical Considerations

Data were collected electronically, and the lack of demographic information collection allowed for anonymity. Consent information was hosted on the researchers' personal computer and safeguarded by a password. Study participation resulted in minimal risks to respondents. In this study, all rules stated to be followed within the scope of theHigher Education Institutions Scientific Research and Publication Ethics Directive" were followed. None of the actions stated under the title "Actions Against Scientific Research and Publication Ethics", which is the second part of the directive, were not taken.
Ethical review board name: Necmettin Erbakan University Sciences Scientific Research Ethics Committee.
Date of ethics review decision: 09/07/2021.
Ethics assessment document issue number: :2021/414.

Findings

The research findings reached because of the analyses realized with the aim of examining the participant mathematics teachers and pre-service teachers' opinions about the practices of distance education and the expressions about students' and their parents' worries about the functionality of the distance education practices in mathematics education are given in this section. In this scope, the findings reached as the results of the descriptive and content analysis of the data obtained for the three research problems included are explained in this part.

Primarily, the two themes determined to answer these research problems, which were "What are the mathematics teachers' positive and negative opinions about distance education practices?" and "What are the mathematics pre-service teachers' positive and negative opinions about distance education practices?". These themes were examined by gathering under the sub-themes of the mathematics pre-service teachers' and pre-service teachers' positive and negative opinions about the practices of distance education in mathematics, with the aim of examining the participants' mathematics teachers' and pre-service teachers' opinions about the practices of distance education. The data obtained because of gathering the answers given by the participants to these problems under these three different sub-themes is presented below.

In this study, the distribution of the expressions used by the participants according to three general themes in which the opinions of 37 mathematics teachers and 90 pre-service teachers participating in the research on distance education were examined is given in Table 1.

Table 1. Distribution of participants' statements to themes

	Pre-service teachers		Mathematics teachers		Total	
	f	%	f	%	f	%
Positive and negative opinions on the Distance education practices of participants	25	12.2	16	9.2	10	7.8

Participants' Opinions on Distance Education Practices

The 90 participants answered the research problem addressed to themselves and stated as "What are the mathematics pre-service teachers' positive and negative opinions about the practices of distance education?" by using 675 statements. In addition, 37 participant mathematics teachers answered the research problem addressed to themselves and stated as "What are the mathematics pre-service teachers' positive and negative opinions about the practices of distance education?" by using 258 statements in the study. The distribution of these participants' statements in relation to their positive and negative opinions about the practices of distance education for the three sub-themes of the study is given in Table 1.

Table 2. Distribution of positive/negative opinionsandsub-themes for distance education

	Pre-service teachers		Mathematics teachers		Total	
	f	%	f	%	f	%
Positive Thought	398	58,9	112	43,4	510	54,7
Negative Thought	222	32,9	116	45,0	338	36,2
Neutral	55	8,2	30	11,6	85	9,1
Total	675	100,0	258	100,,	933	100,0

From the varied data analyses, it was observed that an important part of the participants' statements related to their opinions about the practices of distance education was positive. They were observed to use positive (54,7%), negative (36,2%), and neutral (9,1%) statements. For participant mathematics teachers, it was found that nearly half of the statements (43,4%) related to the mathematics teachers' opinions about distance education practices were positive. However, it is observed from the table that the number of negative statements used by the mathematics teachers is higher (45%). In contrast to participant mathematics teachers, it was declared that an important part of the participant pre-service teachers' statements related to their opinions about the practices of distance education was positive. They were observed to use positive (59%), negative (32,8%), and neutral (8,2%) statements. The codes determined within the scope of the subthemes related to the participants' positive and negative opinions about distance education practices are explained in detail in the following tables.

First, the pre-service teachers' opinions on the practices of distance education are explained in Table 3.

Table 3. Sub-themes/codes related to pre-service teachers' opinions on distance education

	Pre-service teachers	
	f	%
Positive Thought	398	59,0
Easy Access	154	22,9
Repeatability	73	10,9
Economy	67	9,4
Enriched environment	54	8,1
Organizability	26	3,9
Individuality	18	2,8
Transparency	6	1,0
Negative Thought	222	32,8
Lack of interaction	60	8,9
Access impossibilities	54	8,0
Technological infrastructure	48	7,1
Lesson management disorders	34	5,0
Physical environment disorders	20	2,9
Measurement errors	6	0,9
Neutral	55	8,2
Total	675	100,0

While the participant pre-service teachers explained their statements revealing their positive opinions about the distance education practices, they used statements mostly related to the sub-themes of easy access and repeatability (22,9% and 10,9%, respectively). Moreover, the other positive statements related to the sub-theses of being economic and opportunity for an enriched environment (9,4% and 8,1%, respectively) also indicate that these pre-service teachers had positive opinions about distance education practices. Moreover, while they explained their statements revealing their negative opinions about distance education practices, they used statements mostly related to the sub-themes of lack of interaction, access impossibilities and technological infrastructure (8,9%, 8,0% and 7,1%, respectively). Hence, it is observed that their positive opinions on distance education practices focus on the sub-themes of easy access and repeatability. It is observed that the participant pre-service teachers' negative opinions about distance education practices result from the lack of teacher– student, student–student, and material– student interactions in courses, difficulties experienced during access to distance education courses, and insufficiency resulting from technological infrastructure. It was also observed that approximately 8,2% of them did not state any positive or negative opinions, but used neutral statements.

Below are some examples related to these pre-service teachers' positive opinions on distance education practices.

Starting from the sub-themes of easy access to distance education practices and the repeatability of courses, we can state that the pre-service teachers' positive opinions stated as "we can watch what we have not understood often" and "we can listen to our courses and take notes whenever we like" indicate their favorable opinion about these practices.

Below are some examples related to these pre-service teachers' negative opinions on distance education practices.

It is observed that the negative opinions of their stated as "The students could not experience the collaborative learning environment, peer teaching very much.", "Courses passed as if we listened to conferences." resulted from the lack of communication in relation to the distance education practices. Moreover, it is also observed that their negative opinions stated as "Moreover, we cannot obtain the books every time. We have difficulty in accessing the library" resulted from the difficulties they had in accessing distance education courses. Similarly, it is observed that these pre-service teachers' negative opinions stated as "We had many connection problems", "In distance education, we solved less mathematics problems because we could see less board area", "Not all of us are sufficiently equipped,

so we may fall behind in the class" resulted from the insufficiency of technological infrastructure related to distance education practices.

The codes determined within the scope of the sub-themes related to the participant mathematics teachers' positive and negative opinions about distance education practices are explained in detail in Table 4.

Table 4. Sub-themes/codes related to mathematics teachers' opinions on distance education

	Mathematics teachers	
	f	%
Positive Thought	112	43,4
Easy Access	8	3,1
Repeatability	0	0,0
Economy	27	10,5
Enriched environment	45	17,4
Organizability	5	2,0
Individuality	13	5,0
Transparency	14	5,4
Negative Thought	116	45,0
Lack of interaction	52	20,2
Access impossibilities	8	3,1
Technological infrastructure	10	3,9
Lesson management disorders	15	5,8
Physical environment disorders	18	7,0
Measurement errors	13	5,0
Neutral	30	11,6
Total	258	100,0

While the participant pre-service teachers explained their statements revealing their positive opinions about the distance education practices, they used most statements (17,4%) in relation to the enriched environment sub-theme. The mathematics teachers stated that computer-assisted education was advantageous, they gained experience by integrating technology into mathematics education, and they added visual content to courses via online materials and Z books. In addition, it was understood that they used most statements for the sub-theme of lack of interaction (20,2%). When the teachers' statements related to their negative opinions were examined, it was understood that the teachers could not get in touch with their students, the students' social communications with their peers and teachers weakened, and their lesson motivations and attention spans were at a minimum level during the distance education process.

Below are some statements related to the participant mathematics teachers' positive opinions on distance education practices.

According to this, statements such as "…I think its positive effect is related to performing new generation question solving has become easier via digital applications", "In my math courses, on Google Jamboard, I could take colorful notes, solve plenty of examples, draw figures easily and then share them with my students" and "…since distance education process allows for different practices, I find it useful for mathematics teaching" indicate that distance education provides mathematics teachers with an enriched environment. Moreover, the participant mathematics teachers stated their positive opinions in relation to the sub-theme of transparency via such statements as "I think the courses were taught better with the students participating in the lesson because there was not a problem like dealing with uninterested students in the classroom", and they also stated their positive opinions in relation to the sub-theme of economy via such statements as "In a short time, the acquisitions which need giving were taught. Since there are no out-of-lesson talks in distance education, the teacher could teach the courses more easily" and "Doing the courses by sitting at the computer was positive for those who are both mothers and teachers like me because we did not have to go out of our homes."

Below are some statements related to the participant mathematics teachers' negative opinions on distance education practices.

The mathematics teachers expressed their negative opinions about the sub-theme of lack of interaction via such statements as "Especially in subjects like geometry, which requires the use of tangible materials, the fact that the materials were shown on the screen and the students were not able to examine these materials personally made their learning difficult." , "What's worse, I had some students who did not give any reaction when I called their names (most likely, the ones who were not at the screen / the ones who were concerning themselves with things other than the lesson even if they were sitting at the computer /the ones who started the lesson and slept just over there / the ones who turned the volume of the lesson down and went on playing games)" and "It fell short of making an eye-contact and providing instant feedback". They expressed their negative opinions about the sub-theme of access impossibility via such statements as "the negative aspect of distance education was that the students without a computer, tablet, or smartphone could not join the courses" and "Since especially students living in rural areas had Internet problems, it was difficult for them to join the courses". They expressed their negative opinions about the sub-theme of physical environment disorders via such statements as "The problems of attention deficit and adaptation in the comfortable environment at home are, too, among their negative sides." It was observed that 11,6% of the mathematics teachers remained neutral to the distance education process of mathematics education by not expressing any positive or negative opinions.

Participants' Opinions related to Students' and Their Parents' Worries about the Functionality of Distance Education Practices

37 participant mathematics teachers answered the research problem stated as "What are the students' parents and the students' worries about the functionality of the distance education practices in mathematics education?" with 100 statements. The sub-themes created by using the statements in relation to how the teachers perceived and explained the students' parents and their worries in the process in which mathematics education was realized via the distance education practices are shown in Table 5.

Table 5. Distribution of teachers' expressions about students' parents and students' worries about the functionality of distance education practices in mathematics education

	f	%
Worry	91	91,0
General Anxieties	17	17,0
Distrustfulness	22	22,0
Domestic unrest	14	14,0
Financial difficulties	2	2,0
Fruitlessness	30	30,0
Lack of knowledge	6	6,0
Those who expressed having no worries	9	9,0

In this study, when the distribution of the statements of the mathematics teachers in relation to the kinds of worries that the students' parents and the students had about the functionality of the distance education practices in mathematics education was examined, it was found that while 91% of the students' parents and the students had some worries, 9% of them did not have any worries. The students' parents and their worries focused mostly on the distance education practicesbeing fruitless (30%) and distrustful (22%) in mathematics education.

Below are some examples related to the participant mathematics teachers' opinions about the students' parents and the students' worries related to the functionality of distance education practices in mathematics education.

The participant mathematics teachers stated that the distance education practices were fruitless in mathematics education by referring to the students' parents and the students' worries about the functionality of the distance education practices in mathematics education by expressing opinions stated as "The students' parents and the students think that they cannot benefit from distance education, they cannot get education as good as face-to-face education", "The students' parents' worries because the students' attention are continuously distracted and they cannot learn the topics well have increased" and

"The students already have difficulty in understanding the subject of mathematics, they do not understand it at all in the distance education process." Under the sub-theme of distrustfulness, they gave utterances to the students' parents and the students' worries by expressing opinions stated as "There are worries about the reliability of distance measurement and evaluation works" and "Since mathematics is generally perceived as a difficult subject, they worried that distance education might negatively affect their performance levels negatively."

Participant 90 mathematics pre-service teachers answered the research problem addressed to themselves and stated as "What are the students' parents and the students' worries about the functionality of the distance education practices in mathematics education?" by using 350 statements. The distribution of the statements related to how these participants perceived and explained the students' parents and their worries about the functionality of distance education practices in mathematics education for the sub-themes of the study is given in the following table.

Table 6. Distribution of pre-service teachers' expressions about students' parents and students' worries about the functionality of distance education practices in mathematics education

	f	%
Worry	311	88,9
General Anxieties	101	28,9
Distrustfulness	70	20,1
Domestic unrest	52	15,0
Financial difficulties	42	12,1
Fruitlessness	33	9,5
Lack of knowledge	11	3,3
Those who expressed having no worries	39	11,1

In the analyses, it was observed that an important part of the statements related to the participant pre-service teachers' opinions about the students' parents and the students' worries about the functionality of the distance education practices were worry-indexed. According to the pre-service teachers' opinions, it was determined that 88,9% of the students' parents and the students had opinions including worries about the functionality of the distance education practices in mathematics education and 11,1% of them shared opinions not including any worries. However, it was observed that the participant pre-service teachers' opinions, including worries about the functionality of distance education practices in mathematics education, concentrated on the sub-themes of general anxieties and distrustfulness. Some examples related to these participant pre-service teachers' opinions about the students' parents and their worries in relation to the functionality of distance education practices in mathematics education are given below.

The participant mathematics pre-service teachers' opinions stated as "The students' attitudes toward mathematics due to its difficulty have worried the students' parents" and "Finishing the courses in time; they were worried about that the student can even hardly understand in face-to-face education, how can they understand in distance education" in relation to the students' parents and the students' worries about the functionality of the distance education practices, indicate, starting from the sub-themes, that they had general anxieties about the distance education practices. Consequently, the subtheme in which these states of worry had the highest frequency was explained as general anxieties in which the students' and parents' distrust in distance education and domestic unrest occurred during the process of distance education. Moreover, the opinions stated in relation to the sub-theme of distrustfulness, which is another frequently observed sub-theme, are as follows: "According to the students' parents, the students were detached from the courses; they pretended to be at the computer, but they were interested in different things." These opinions indicate that the pre-service teachers thought that the students' parents and their worries created distrust in relation to the functionality of distance education practices in mathematics education.

Discussion and Results

According to the findings of the study, it was determined that an important part (59%) of the statements related to the pre-service teachers' opinions about distance education practices were positive. In contrast, some pre-service teachers (8%) were indecisive about expressing opinions in relation to distance education practices. It was observed that the pre-service teachers' positive opinions on distance education practices concentrated on the sub-themes of easy access and repeatability. The participant pre-service teachers were observed to think that their negative opinions about the distance education practices resulted from the lack of teacher– student, student– student, and material– student interactions in the courses, impossibilities encountered in the access to distance education, and insufficiency resulting from technological infrastructure.

When the findings were examined, it was observed that the mathematics teachers' positive and negative statements related to their opinions about distance education practices were close to each other (43,4% and 45%, respectively). When these statements were compared with those of the pre-service teachers' statements, it was determined that the number of positive statements did not decrease significantly, but there was a rather high increase in the number of negative statements. In other words, compared to mathematics pre-service teachers, mathematics teachers think more negatively about distance education practices. The theme in which the mathematics teachers thought that the effect of distance education practices on mathematics education was positive was the theme of "It provides an enriched environment". The mathematics teachers were observed to state that computer-assisted education was advantageous; they gained experience by integrating technology into mathematics education and added visuality to courses via online materials. However, the sub-themes of transparency and economy were the other statements that were dwelled upon. Moreover, when the statements of the answers given by the mathematics teachers indicated that the effect of the distance education practices on mathematics education was negative, it is eye-catching that they used most statements for the sub-theme of lack of interaction. When the statements belonging to the negative opinions were examined, it was observed that the teachers could not get in touch with their students during the distance education process, the students' social communications with their peers and teachers weakened, and their motivations and attention spans were at minimum level. According to Kanuka (2011), rather than the way education is performed in a face-to-face or online manner, the level of interaction determines the quality of a student's education experience. The main reason for the opinions stated in this study in the direction that distance education created a lack of interaction might be the participants' having a low level of distance education experience. In distance education, lack of communication between a student and a teacher, insufficient feedback, and insufficient support are seen as the most important disadvantages (Wacker, Unger, & Rey, 2020). In this respect, gaining experience and teachers' showing development in this direction might contribute to the decrease in the number of negative opinions.

One of the positive points upon which both the teachers and the pre-service teachers dwelled was the advantages of the possibility of easily accessing the distance education practices, economy, and enriched environment. These opinions show similarities to the results of the study by Katane, Kristovska, and Katans (2015), which stated that distance education provides opportunities for individualization and accessibility in education. According to Moore (1990), together with the popularization of new technologies, if individual differences are respected and knowledge about characteristics specific to learning style is included in the teaching design of distance learning, it will undoubtedly enhance a learning activity.

Some fears are occurring in relation to the possibility that social inequalities will increase between students who have a better socio-cultural status (those who have their own rooms and required digital infrastructure) and those who do not (Hurrelmann & Dohmen, 2020). The pre-service teachers expressing opinionssimilar to this idea mentioned the impossibilities encountered in accessing distance education courses and the insufficiency resulting from the technological infrastructures. This situation is an indication of the fact that the students who do not have their own rooms and required digital infrastructure are not on the same terms as the ones who have their own rooms and required digital infrastructure, and this situation causes them to express negative opinions about the distance education practices.

The findings of the study indicated that according to the mathematics teachers, while 91% of the students' parents and students felt worry about the functionality of the distance education practices in mathematics education, 9% of them did not feel worry. According to the mathematics teachers, the students' parents and their worries concentrated on the thought that the distance education practices were fruitless and distrustful in mathematics education.

It was observed that an important part of the statements of the pre-service teachers in relation to the students' parents and the students' worries about the functionality of the distance education practices education were worry-indexed. According to the opinions of the pre-service teachers, it was determined that about the functionality of the distance education practices in mathematics education, 88,9% of the students' parents and the students had opinions including worry and 11,1% shared opinions not including worry. However, it is observed that the participants' worry-including opinions about the functionality of distance education practices in mathematics education concentrated on the sub-themes of general anxiety and distrustfulness.

Mathematics teachers and pre-service teachers shared the worry that distance education practices were not confident. Another shared point was that the students' parents and the students had a rather high level of worry related to distance education practices. The generally stated worries were briefly explained as the students' parents' distrust in relation to distance education practices and domestic unrest occurring during distance education.

When distance education practices are considered, due to the difficulty of explaining mathematical concepts, they should focus on mathematics in which distance education is challenging (Frid, 2002). However, it was determined that the participants considered the effect of the difficulties raised by the mathematics curriculum to be less important than that of the difficulties caused by students. It is known that there is a strong correlation between a student's level and the curriculum level (Mailizar et al., 2020), and this strong correlation and, to a certain extent, the commonly known strong correlation between school culture and student success, might account for the fact that a student's level creates the biggest obstacle before the ICT integration in the class (Demirtas, 2010).

In conclusion, it indicates that schools, one of the most important stakeholders of education, are required to play an important role in overcoming the difficulties that students have in using e-learning during difficult periods such as pandemics. In this study, it was found that teachers and pre-service teachers had different positive and negative opinions on distance education practices.

Limitations and recommendations

It has become a known fact that technological change will continue and, probably, its speed will increase, and distance learning will become more prevalent, especially in the field of education. In this context, to follow the latest novelties in place of determining our own direction, it will be more appropriate to focus on "what is the latest technology" in place of "what is worth investigating". In today's rapidly changing technological view, Romberg (1989: 254) put forward the idea that it is important that studies in mathematics education should determine the current status and developments should be future-oriented.

In traditional instruction in Turkey, students complete their courses and homework assignments and receive education in classrooms and at home. The change that online learning has brought to the forms of space and time surrounding (mathematics) education is encouraging quantitative change so much that it might dialectically turn into a qualitative change. In relation to this matter, the mathematics teachers and the mathematics pre-service teachers' positive and negative opinions were inquired. In general, it was observed that the teachers' and the pre-service teachers' opinions on distance education practices showed differences. Although it was observed to facilitate life in general, it was determined that it was thought to change some dynamics of education.

Students' access to mobile technologies might create a student– mathematics relationship, which has not been commonly adopted by mathematics educators, breaks up the traditional flow of mathematics

knowledge from teacher to student and is not understood well from the research perspective. The potential of distance education practices in ruining the institutional and hierarchical nature of traditional education, providing students with opportunities for accessing courses without any requirements, and affecting the quality of courses should be investigated. Mathematics education, as the participants stated, also provides a large accumulation in terms of practice area. In this respect, how this accumulation affects the quality of courses should be investigated. This situation will bring how distance education practices are required to design pedagogically along to the agenda again. The collaborative and social network possibilities of the current technologies and personal learning environments have accelerated the development of distance education practices. However, these new developments are calling forth new questions about the design and use of distance education practices in mathematics education.

In this study, although both mathematics teachers and mathematics pre-service teachers' opinions about distance education practices have different priorities, they are not completely independent from each other. There are great intersections and relationships between the themes realized in this analysis and bringing the intersecting aspects to the agenda. First, problems related to the nature of new mobile/digital technological tools supporting access to mathematics and mathematics education knowledge/information and changing the nature of student-information-teacher-context interaction were realized. This field needs to be investigated in more detail. When the targets are related to mathematics and mathematics education, there is a need to elaborate the pedagogical design of mathematics education using new technological tools. The students' parents and the students' worries about the functionality of the distance education practices in mathematics education, which is another theme, are toward the impossibility of mathematics education via distance education. Although this prejudice about this matter can be considered as required by the applied nature of mathematics education, how this is overcome via various designs and pedagogical supports should be investigated.

Implications

This study was a qualitative study, whose evaluation was made via qualitative analysis methods. In future studies, quantitative methods will be used. Within the scope of the study, only a limited number of teachers could be reached. More comprehensive studies can be conducted with the participation of more teachers. This study, which was conducted in the field of mathematics education, can be repeated in different fields such as science and social studies.

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Effect of Authentic Learning Activities in Mathematic Courses on Middle School Students' Academic Achievement and Reasoning Skills

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ABSTRACT
The aim of this study was to determine the effect of activities based on the authentic learning approach used in middle school mathematics courses on students' academic achievement and reasoning skills. The research covers the learning outcomes of the Whole Numbers, Fractions, and Decimal Fractions units in the sixth grade first semester of the mathematics course. The research was implemented in the first semester of the 2022-2023 academic year in a public school in the Selçuklu district of Konya province. The control and experimental groups consisted of 33 and 26 sixth-grade students, respectively. The study was conducted for nine weeks during the fall semester. The data of the study were collected with "Academic Achievement Test" and "Reasoning Skills Test". T-test statistics were used to analyze the data. Because of the study, it was observed that authentic learning activities used in mathematics lessons positively affected students' academic achievement and reasoning skills. These results show that learning experiences close to daily life skills also contribute to reasoning skills.

Keywords: Authentic learning, reasoning skills, mathematics

Introduction

Mathematics is a subject that is often remembered by students because of the difficulties they experienced in school. However, it is not only a part of the school curriculum but also has relevance in every aspect of our daily lives (Hacısalihoğlu et al., 2004). Mathematics has been used to solve many problems that people face directly or indirectly since ancient times, and its relations with different contexts are constantly being redefined (Demir et al., 2023). Mathematics is an important cornerstone in the development of societies. It has been used to determine the boundaries of the lost lands of ancient Egyptians who were engaged in agriculture by the Nile River (Uğuz, 2022). Today, it is used in the development of fields such as artificial intelligence and technology. The significance of teaching mathematics leads to an increased emphasis on its acquisition, which can cause fear and anxiety in many students (Tobias & Weissbrod, 1980). However, several studies have observed a correlation between anxiety and low achievement (Chang & Beilock, 2016; Dowker, Sarkar, & Looi, 2016; Suarez-Pellicioni, Nunez-Pena, & Colome, 2015). Researchers feel compelled to experiment with different designs or approaches to teaching mathematics because of anxiety and fear.

Freudenthal (1971) argues that mathematics is not a closed system to be learned, but rather a discipline in which the learner is active. According to this view, mathematics is a human activity that begins with real-life problems, and formal mathematics is reached only after the mathematization of real-life situations. Today, this teaching approach, based on the constructivist perspective, is known as realistic mathematics education (Van den Heuvel-Panhuizen, 2003). Connecting mathematics with real-life situations aligns with the notion that learning contexts impact both concept formation and development (Vygotsky, 1986). Authentic learning, or real-life-like contexts, is crucial as it provides concrete situations for acquiring everyday concepts. This learning approach facilitates effective learning in various courses, particularly mathematics, which is often viewed as the most abstract.

Authentic Learning

Authentic learning refers to an instructional approach that situates learning experiences in real-world contexts and activities. It is grounded in the constructivist theory, which posits that learning occurs most effectively when learners are actively engaged in building knowledge and making meaning from experiences that resemble real-life scenarios. Authentic learning involves the use of authentic tasks, resources, and environments that are directly relevant to learners' lives and goals. By presenting learners with genuine problems and challenges that mirror those encountered in professional settings, authentic learning bridges the gap between theoretical knowledge and practical application (Newmann, et al., 1992; Lombardi, 2007).

Learners assume roles akin to the work they may undertake in the future, fostering the development of relevant skills, strategies, and dispositions. They engage in complex activities such as case studies, projects, or simulations that require research, collaboration, and critical thinking skills to navigate ambiguous situations that lack a prescribed solution path (Wiggins, 1990; Newmann, & Wehlage, 1993). Authentic assessments are an integral part of this approach, measuring learners' ability to effectively use acquired knowledge rather than merely recalling information.

The authenticity inherent in these learning experiences enhances motivation and engagement as learners find relevance and purpose in their endeavors. It facilitates the transfer of knowledge to novel situations beyond the classroom setting by enabling learners to practice applying concepts in realistic contexts (Renzulli et al, 2004; Herrington, & Herrington, 2006). Ultimately, authentic learning equips learners with the capacity to successfully confront complex real-world challenges by developing essential skills like problem-solving, decision-making, self-directed learning, and adaptability to dynamic environments.

Authentic Learning in Mathematics

Authentic learning involves working on real-world problems and actively participating in the solution (Lam, 2013). The authentic learning model is a process that leads to true mastery through experiences

(Nordquist, 1993). This teaching model focuses on complex problems and includes role-playing, simulations, and real-world applications. Authentic learning involves students finding knowledge in real contexts, using multiple methods to access it, and applying it to gain experience (Newman et al., 1995). This process equips students with skills that extend beyond memorization and are applicable throughout their lives (Lombardi, 2007). It also challenges them with complex problem-solving tasks. In this process, students encounter decision-making situations similar to those in their daily lives (Lombardi, 2007). Authentic tasks require individuals to make decisions using a variety of knowledge and skills (Perreault, 1999). Therefore, authentic learning offers an important experience for students to develop decision-making skills, which are necessary in the 21st century. Many students perceive mathematics as a subject that requires rote memorisation, without understanding its practical applications. They often view it as a collection of formulas (Tobias & Weissbrod, 1980). To address this, an authentic learning strategy can be employed, which connects mathematical concepts to real-life situations, demonstrating that abstract knowledge has tangible applications in daily life. Therefore, the use of authentic learning strategies facilitates the mental organization of information and enhances the enjoyment of the learning process (Aydın-Aşk, 2016). This approach not only promotes students' interests in the subject matter but also emphasizes that the lesson is not solely based on rote memorization. Consequently, individuals who structure their knowledge rather than relying on memorization tend to retain information more effectively (Koçyiğit & Zembat, 2013). It is evident that a learning environment where students have the opportunity to work and experiment independently can enhance their academic performance and mathematical reasoning abilities, as well as foster their development as mathematicians.

Authentic Learning and Mathematical Reasoning

Various studies have focused on the mathematical thinking processes of students (Tüzün & Cihangir, 2020). Specifically, their problem-solving strategies or steps, which are fundamental skills (Hatay & Cihangir, 2021), are noteworthy because of the nature of mathematics. During mathematics lessons, students apply these strategies to real-life situations and arrive at solutions with ease (Aydın, 2019). This teaching is based on five basic principles: higher-order thinking, in-depth learning of information, making connections with the real world, sharing ideas, and providing social support (Newmann & Wehlage, 1993). Authentic learning activities equip students with the high-level skills required in mathematics. Possessing these skills has a positive impact on students' mathematical achievements (Ayotola & Adedeji, 2009; Hackett, 1985). It aids in the development of individuals who have high confidence in their mathematical abilities, are interested in mathematics, focus on problem-solving, and use their mathematical skills effectively (Echazarra et al., 2016).

The authentic learning approach develops students' mathematical thinking skills based on reasoning (Umay, 2003). The main objective of mathematics education is to equip students with reasoning skills that involve making observations, assumptions, logical inferences based on certain assumptions, and reasoning (Mullis et al., 2020). Reasoning encompasses various functions such as theory construction, systematization, and discovery in mathematics. Reasoning underlies the rules and procedures in mathematics and is used to establish facts rather than experimentation and observation (Umay & Kaf, 2005, p.188). Mathematical reasoning enables deep learning (Stylianides, 2010, p.44) and involves a high-level thinking process that elaborates and makes sense of a problem or situation by asking "Why" and "How" questions (Erdem, 2011, p.15). Critical and creative thinking are prerequisites for reasoning. Reasoning is the final step in the thinking process and is a crucial aspect of mathematical thinking (Umay, 2003, p.235). To develop reasoning skills, it is essential for students to interact , generate and share ideas. Teachers can facilitate the development of mathematical reasoning by encouraging collaborative work and presenting problems that require reasoning. Additionally, students should be given the opportunity to solve problems independently. The aim is to create an environment in which students can justify their ideas (Lithner, 2008). By engaging in cooperative learning within an authentic learning environment, students can exchange ideas with their peers and generate multiple solutions to

problems (Aydın, 2019). In conclusion, the use of an authentic learning approach in mathematics lessons is highly significant.

Based on the effect of authentic learning on mathematics achievement and reasoning skills, this study aimed to answer the question "What is the effect of using activities based on authentic learning approach used in mathematics courses on the academic achievement and reasoning skills of middle school students?". To this end, answers the following questions were sought:

1. Is there a significant difference in academic achievement gain scores between the experimental and control group students who were exposed to authentic learning activities in a mathematics course?
2. Is there a significant difference in reasoning skill gain scores between students in the experimental group, who participated in authentic learning activities during their mathematics course, and those in the control group?

In mathematics education, it is extremely important that students develop not only rules and procedural skills but also mathematical reasoning and problem-solving skills. An authentic learning approach can contribute to the development of these skills by enabling students to learn mathematical concepts in real-world contexts through meaningful activities. Therefore, an experimental study examining the effects of authentic learning on mathematics achievement and reasoning skills would make important contributions to the field of education. Such a study could provide guidance to teachers and educators on how to effectively implement authentic learning strategies to improve students' academic performance and problem-solving skills. It can also provide a basis for exploring ways of integrating authentic learning into the mathematics curriculum and examining the long-term effects of this approach. The findings of this study can lead to reform efforts in mathematics education and the adoption of student-centered teaching methods.

Method

Research Model

This study investigated the impact of activities based on an authentic learning approach on the academic achievement and reasoning skills of middle school students of mathematics. The study employed a quasi-experimental design, specifically the pretest-posttest paired control group model. The dependent variable was measured for participants before and after the experimental procedures (Büyüköztürk, 2011).

Lesson plans were prepared for the experimental and control groups before the application, considering the learning outcomes of the mathematics course. The teaching activity was then conducted within this framework. The experimental group underwent teaching activities based on authentic learning for the relevant outcomes within the research framework. In the control group, the teaching activity was conducted according to the curriculum. Tools based on academic achievement and reasoning skills were used to conduct the study both before and after the experimental process. In experimental design studies, the groups related to the subject being researched were matched as closely as possible (Johnson, & Christensen, 2012).

Table 1. Research Model

Group	Pretest	Independent Variable	Posttest
E	T1, T2	X	T1', T2'
C	T1, T2		T1', T2'

The table above shows the pretest-posttest paired control group design model of the study. E indicates the experimental group and C indicates the control group. T1 and T2 indicate the mathematics achievement and mathematical reasoning tests taken by the groups. Both tests were administered to the two groups as pre-test and post-test. X represents the independent variable of the study, which is the authentic learning activities implemented in the mathematics course.

Study Group

Study participants were selected using a convenience sampling technique. Due to time and resource constraints, the researchers conducted the research in their own classrooms using convenience sampling. The research was conducted during the first semester of the 2022-2023 academic year in two different classes: one control and one experimental, at an average public secondary school in Selçuklu district of Konya province. The researchers themselves developed and conducted the activities and teaching plans. The control group consisted of 33 students, whereas the experimental group had 26 students. To determine the study group, a pretest was administered to all classes at the relevant-grade level in the research school. The experimental and control groups were defined as relatively equivalent. The study employed a quasi-experimental design, and the participants were not selected completely randomly.

Instruments

The study data were collected using two instruments: the Academic Achievement Test and the Reasoning Skills Test. The researchers developed the academic achievement test, while the reasoning skills test was adapted from Pilten's (2008) test items. Please see the following for further details on both instruments.

Development of a Math Academic Achievement Test

The process of developing the academic achievement test is explained below with its steps.

1. Purpose of the developed test: This test measures the academic achievement of students of mathematics. The test covers the learning outcomes of the units Whole Numbers, Operations with Fractions, and Decimal Representations in the first semester of the sixth-grade mathematics course. The topic of fractions was selected because of the challenges students face in comprehending this area of learning.

2. Determining the characteristics to be measured using the test: The test determined the extent to which students acquired the 17 learning outcomes of the sixth-grade mathematics course. At least one question was included for each behavior in the draft instrument.

3. Writing the items The items were prepared by considering the learning outcomes specified in the 6th grade 1st semester of the MoNE mathematics curriculum for the 2022-2023 academic year. The questions were designed with attention to the cognitive level of the learning outcomes and were selected from the central exam (scholarship) question pool conducted by the Ministry of National Education in previous years. The researchers who evaluated the draft items were specialists in measurement, evaluation, and mathematics education. The pilot form was designed on the basis of expert opinions and consists of 31 multiple-choice items. Each item has four options.*4. Conduct the trial application.* The test form was administered to 102 students in a higher grade (7th grade) at a different secondary school where the learning activity related to these learning outcomes had been conducted previously. Item discrimination and difficulty indices were calculated for the test items. After analysis, five items were removed from the test because of low discrimination indices. This study aimed to determine if this version of the academic achievement test resulted in any deficiencies in the assessment of outcomes. The results indicated that a final test comprising 26 items covering the objectives could be administered. The KR20 value for the entire test was calculated to be 0.83, and the discrimination values of the test items ranged from 0.33 to 0.68, indicating an average level of difficulty. Table 2 displays the item discrimination indices.

Table 2. Academic Achievement Test Item Discrimination Indices

	i2	**i3**	**i4**	**i5**	**i6**	**i8**	**i9**	**i10**	**i11**
rjx	0.53	0.51	0.45	0.51	0.68	0.42	0.42	0.33	0.61
	i12	**i13**	**i14**	**i18**	**i19**	**i20**	**i21**	**i22**	**i23**
rjx	0.37	0.56	0.51	0.41	0.39	0.45	0.62	0.54	0.51
	i24	**i25**	**i26**	**i27**	**i28**	**i29**	**i30**	**i31**	
rjx	0.50	0.47	0.50	0.40	0.44	0.39	0.32	0.47	

rjx: item discrimination ix: item number

5. Scoring the answer sheets and item analysis.

The scoring key was used to score the answer sheets. Incorrect answers were given a score of 0, whereas correct answers were given a score of 1. The students' answer sheets were then analyzed.

Reasoning Skills Test

The "Reasoning Skill Test" used to assess mathematical reasoning skills was adapted from a test developed by Pilten (2008). The test was created for use in a doctoral dissertation titled 'The effect of teaching metacognitive strategies on the mathematical reasoning skills of primary school fifth grade students'. The test consists of 41 items. These items consist of open-ended and multiple-choice questions that include the qualities of Identifying and using appropriate reasoning, recognizing and using mathematical patterns, recognizing different representations of the same data, logical arguments, prediction, decision making, generalization, and non-routine problems. While the reliability of the test was 0.87, the test-retest reliability was calculated as 0.76. The measurement tool, which was reorganized within the scope of this research, includes 24 items that examine the achievements of the subjects in "Whole Numbers, Fractions, Decimal Fractions."

Procedure/ Process

Students in the experimental group were subjected to teaching procedures based on the authentic learning approach on fractions. In this context, students were asked to address problems related to fractions that they might encounter in real life and to develop solutions. Students had to resort to fraction operations for real-life experiences. In this process, the students had to understand, compare, transform, and use fraction concepts in operations. The teacher only acted as a guide, allowing the students to construct their own learning. Through this authentic learning experience in a real-world context, the students learned fractions in a more meaningful and lasting way.

Students in the control group were taught traditional teaching methods. The fraction topic was taught through abstract examples and exercises using a teacher-centered approach. The teacher conveyed fraction concepts, operations, and rules by writing on the board and solving questions. The students were then asked to complete the exercises and assignments in the textbook. These exercises often included numerical examples and problems. Students had to memorize only abstract concepts and operations without directly experiencing the real-life uses and applications of fractions. The teacher provided the correct answers and formulas, while the students passively listened and took notes.

Data Collection

Before the experimental procedure, both groups were given a mathematics achievement and reasoning skills test to assess their existing competencies related to the mathematics course objectives. After the 9-week experimental period, the same test was administered as a post-test for both groups.

Data Analysis

The study analyzed quantitative data for the subproblems related to the main research purpose. The data was organized using Excel. Statistical package programs were used to analyze the first and second subproblems. The data collected with the Academic Achievement Test and Reasoning Skills Test were compared using the dependent t-test (paired samples t-test). The study used a dependent t-test to determine if there was a significant difference between the pretest and posttest scores. In addition, an independent sample t-test was used to compare the academic achievement and reasoning skill scores of the experimental and control groups before and after the study. The significance of the difference between the academic achievement and reasoning skill achievement scores of the experimental and control groups students was tested using the independent t-test.

Ethical Considerations

Within the scope of this research, all activities were conducted in accordance with the Scientific Research and Publication Ethics procedures of Higher Education Institutions. Teaching activities were

based on teaching plans determined within the experimental process. The study was approved by the Necmettin Erbakan University Social Sciences Ethics Committee (Date, 14/10/2022; Decision No, 2022/349)

Findings

Descriptive Findings

This section presents the results of the analysis of the data collection tools used in the study for the experimental and control groups. Table 3 shows the pre-test and post-test score statistics for academic achievement and reasoning skills of both groups.

Table 3. Descriptive Statistics for Academic Achievement and Reasoning Skills Tests

	Academic Achievement Test				**Reasoning Skills Test**			
	Pre-test		**Post-test**		**Pre-test**		**Post-test**	
	$\bar{X}$	**sd**	$\bar{X}$	**sd**	$\bar{X}$	**sd**	$\bar{X}$	**sd**
Experimental Group	3.73	1.61	17.69	4.78	3.07	0.95	16.03	3.86
Control Group	2.67	0.99	14.12	2.31	3.20	1.22	7.44	3.22

The table shows that both groups had similar academic achievement test scores before the application, and both groups showed an increase in the post-test. However, the experimental group showed a higher increase than the control group. Furthermore, it was observed that the achievement levels of both study groups in the reasoning skills test were similar before application. However, there was an increase in both groups after post-test application. The experimental group showed a greater increase than the control group.

Findings Related to the First Sub-Problem

The first sub-problem of the study aimed to determine whether there was a significant difference in academic achievement gain scores between the experimental group, which received authentic learning activities in their mathematics course, and the control group. To answer this question, the academic achievement gain scores of both groups were analyzed using an independent t-test. Table 3 presents the t-test statistics for these results.

Table 4 displays the statistics for the participants' academic achievement attainment scores.

Table 4. Statistics of Participants' Academic Achievement Attainment Scores

Group	**n**	$\bar{X}$	**sd**	***t***	***Cohen's d***
Experimental Group	26	13.96	4.43	2.76	0.73
Control Group	33	11.46	2.44		

The table shows a difference in favour of the experimental group in their average academic achievement gain scores. The t-test results indicate a significant difference ($p<0.01$) due to the authentic learning activities implemented in the mathematics course. It can be concluded that the academic achievement of the experimental group students was significantly improved.

Findings Related to the Second Sub-Problem

The second sub-problem of the study aimed to determine whether there was a significant difference between the reasoning skills achievement gain scores of the experimental and control group students in

which authentic learning activities were applied in mathematics courses. To answer this question, the reasoning skills achievement scores of the groups were analyzed using an independent t-test. The t-test statistics for these results are presented in Table 5.

Table 5. Statistics of the Participants' Reasoning Skills achievements Scores

Group	n	$\bar{X}$	sd	t
Experimental Group	26	13.34	3.12	11.01
Control Group	33	4.36	3.09	

The table shows a significant increase in the average reasoning skills achievement scores of the participants in the experimental group compared with the control group ($p<0.01$). This result indicates that the application of authentic learning activities in the mathematics course had a positive impact on the reasoning skills of the experimental group students.

Discussion and Conclusion

The objective of this study was to investigate the impact of activities based on an authentic learning approach in middle school mathematics courses on students' academic achievement and reasoning skills.The first sub-problem of the research aimed to determine whether there was a significant difference in academic achievement scores between the experimental group students and the control group students in a mathematics course where authentic learning activities were applied. The conclusion drawn was that the implementation of authentic learning activities had a positive impact on students' academic achievement. Providing mathematics lesson outcomes with activities associated with daily life enables students to make sense of the lesson, thus supporting permanent learning. These findings are supported by various studies from different perspectives.

Upon examining the literature on authentic learning, it was observed that the use of authentic learning activities in mathematics lessons was limited. Blum's (2002) experimental study found that the use of authentic learning experiences in mathematics lessons had a positive effect on students' learning and attitudes. Aydn (2019) conducted a study to examine the effect of authentic learning environments on fourth-grade mathematics course success and students' academic self-confidence. This study evaluated the results of the Mathematics Achievement Test and Academic Self-confidence Scale. The conclusion drawn was that authentic learning activities increased students' course achievements and academic self-confidence. The study by Dadlı (2017) and Aynas (2018) discussed authentic learning activities in science teaching and concluded that they have a positive impact on students' academic achievement, attitudes toward the course, and problem-solving skills. The study also found that permanent learning was achieved. Aydn-Aşk (2016) suggests that incorporating authentic learning activities into mathematics lessons can lead to more efficient use of teaching time and support student success. Various studies have highlighted the importance of authentic learning activities in supporting success. Factors such as providing an enjoyable learning environment (Önger, 2019; Balcı, 2021), maintaining motivation (Gürdoğan, 2014), contributing to a positive classroom environment (Horzum & Bektaş, 2012; Hamurcu, 2016), and supporting problem-solving skills have been identified as significant contributors. Johnson and Christensen (2012) conducted a study with emergency management students and found that the use of disaster simulation provided an authentic learning environment and contributed positively to students' learning. Bhagat and Huang (2018) concluded that technology-based applications were successful in addition to basic curriculum subjects.

The study's second sub-problem aimed to determine whether there was a significant difference in reasoning skill achievement scores between the experimental group students, who were exposed to authentic learning activities in their mathematics course, and the control group students. The results showed that the daily life problems used in the authentic learning process contributed to the development of students' reasoning skills. Enabling students to apply the problem-solving method they learned in the classroom to real-life situations can improve their reasoning skills. During this process,

students' elaboration, assumptions, and reasoning contribute positively to their development. studies on reasoning skills based on authentic learning approaches have limitations.
Kara-alşkan (2019) observed that successful students generally used creative reasoning processes when solving non-routine mathematics problems similar to authentic learning activities. Similarly, Mutluoğlu (2009) found that virtual manipulatives used in geometry and measurement had a positive impact on the geometric reasoning of intermediate- and high-achieving mathematics students. According to Dolapcioglu and Doğanay (2022), the teacher's preparation for such experiences is considered a crucial first step.
As demonstrated in our study, other studies on authentic learning methods have also found that such practices enhance academic achievement across multiple courses and promote lasting learning. Furthermore, our study distinguishes itself from others by demonstrating the positive impact of authentic learning activities on students' reasoning skills in mathematics lessons. As a result, the use of authentic learning activities in mathematics courses had a positive impact on students' academic achievement and reasoning skills.

Recommendation

In this section, some suggestions are included in line with the findings and results obtained from the current research.

- Because such activities take a long time, evaluations regarding the time part of the activities in the plan can make the process more efficient.
- It is important to ensure that the problems included in the authentic learning environment are complex and have multiple solutions. Students should be encouraged to actively seek their own solutions within the learning environment.
- Because of the associations between authentic learning activities and daily life, studies on reasoning processes can provide valuable insights.
- To enhance the connection between mathematics lessons and real life, students are given authentic extracurricular tasks in addition to in-class activities.
- In our research, we enriched authentic learning activities with web-based tools. Therefore, incorporating technologically supported tools and materials for artificial authentic vehicles will enhance the learning process, making it more enjoyable and efficient.

Limitations

In this study, experimental research was conducted to examine the effectiveness of the authentic learning approach in mathematics courses. However, as with any research, this study has some limitations. First, the study was conducted in only one public school and excluded private schools or schools with different socioeconomic levels. This situation limits the generalizability of the results. In addition, the fact that the participants were selected only from 7th grade students does not adequately explain the effect of the authentic learning approach in different age groups. Finally, the study only measured students' academic achievement and reasoning skills, ignoring the effects of authentic learning on motivation, attitude, and retention. By highlighting the weaknesses of the study, it is noted that the results should be interpreted more carefully and their generalizability is limited to this context.

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Brown Skin Girl: Mapping Negotiations of Colorism, Digital Resistance, and Black Girlhood

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Brown Skin Girl: Mapping Negotiations of Colorism, Digital Resistance, and Black Girlhood

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ABSTRACT

This study delves into the intricate relationship between the symbolic representation of skin color in virtual avatars and its profound impact on people's self-value within American society. Over time, white skin has been bestowed with societal significance, often associated with power and privilege. This research addresses the profound implications of these avatar choices on individuals' self-identity and the reinforcement of prevailing cultural norms. It highlights the subtle yet impactful ways in which modern technology intertwines with and reinforces societal attitudes toward race and appearance. By shedding light on this phenomenon, this paper aims to encourage further discussions on the potential consequences of associating skin color with value and self-worth in virtual spaces.

Keywords: Black girlhood, colorism, digital resistance, virtual spaces, virtual avatars, cultural norms

Introduction

The internet is a place where identity can be constructed (Anderson, 2022). This includes racial and ethnic identity and the extension of cybercultures that include the networked cultures and electronic environments that are tethered to the digital spaces we move in and throughout. This negotiated digital space of socialization across the last three decades of the 20th century has created a rich transdisciplinary space for inquiry into identity construction and racial and ethnic socialization. In the realm of the internet, there continues to be a liaison between real and performed identities that are often expressed through the creation of avatars (Nishi et. al., 2015; Peck et al., 2022). By definition, avatars are supposed to represent self in digital media environments (Nishi et. al., 2015; Ratan & Sah, 2015) through a mixture of a person's true self and a person's alternative self. The creation of avatars is usually based on the intentions of use or what context the avatar will be operating in (Nishi et. al., 2015).

People use avatars to represent themselves and use tools like customization in order to identify with the avatar. The concept of avatars can be traced back to the 1970s primarily in the field of video games. One of the earliest instances of avatar-like representations was in the game "MUDs" (Multi-User Dungeons) where players used textual descriptions to represent themselves in virtual spaces (Ito, 2013; Sheldon, 2022). In 1980, Garriott released the game "Ultima," which allowed players to control a character called the "Avatar" who could interact with a virtual world (Contato, 2021) In the 1990s, with the rise of the internet avatars became more visually represented. Online platforms like AOL (America Online) allowed users to create and display graphical avatars to represent themselves in chat rooms and forums. In 1995, Will Harvey created the online community "The Palace," which allowed users to interact with each other using customizable avatars in a virtual world (Kushner, 2004). This played a significant role in popularizing the use of graphical avatars in social interactions. Second Life, launched in 2003 by Philip Rosedale's company Linden Lab, became a major milestone in the evolution of avatars (Rymaszewski, 2007). Second Life allowed users to create highly customizable 3D avatars and interact with others in a vast virtual environment. With the rise of gaming consoles like Xbox and PlayStation, avatar creation became a standard feature for gamers in 2008. Social media platforms like Facebook, Instagram, Snapchat, and others integrated avatar creation tools to allow users to personalize their profiles and express themselves visually. Facebook was launched in 2004 by Mark Zuckerberg. In 2008, Facebook introduced the "Profile Picture" feature, allowing users to upload a small image to represent themselves on the platform. In 2019, Facebook launched "Facebook Avatars," a more comprehensive avatar creation tool that enables users to design cartoon-like avatars with various facial features, hairstyles, clothing, and accessories (Wu et. al., 2015). Snapchat, launched in 2011, allowed users to create personalized "Bitmoji" avatars. Bitmoji allows users to design customizable avatars that can be integrated into Snapchat's messaging and Stories features, enabling a more personalized and expressive communication experience (Erinn, 2019). Instagram, launched in 2010, started as a photo-sharing app with minimal avatar representation. In 2019, Instagram introduced "Create Your Own" augmented reality (AR) filters, allowing users to design and share custom filters, including avatar-based filters (de Brito Silva et. al., 2022). Users customize their avatar characters to attract certain social interactions, and the imagined audience, and may even customize avatars that embody aspects contrary to themselves (Williams, 2019). This causes avatar formation to be a form of autoethnography where the creator of the avatar explores relations of power and culture (Kafai et. al., 2010).

Colorism in the United States emerged during chattel slavery, which established the preferential treatment of Africans with lighter skin complexions. (Reece, 2018). The impacts of colorism are deeply entrenched within broader historical contexts, reflecting its pervasive influence across the diaspora and its entwining within our socialization practices. This has shaped socialization practices that prioritize certain skin tones over others. This historical backdrop informs the challenges faced by Black women in leveraging technology, as the biases embedded in digital platforms reflect and perpetuate longstanding discriminatory attitudes. Colorism existing in digital platforms allows us to criticize Black women's leveraging with technology, reimagining digital constraints through the unique lens of Black girls (Steele, 2021).

In charting the negotiations of visual markers in Black girls' body politics, we also capture a need to further extend scholarship on the gatekeeping implications that impact how Black people, especially those at intersections of identity, experience these digital phenomena over time. Historically and presently, Black girls have had to exist within specific limits due to racial norms in society and learn to adapt themself and their appearance (Williams, 2019). Colorist representations of Black girls contribute to hypervisibility and assault on Black girls' bodies. With unprecedented access to images that circulate of Black girls, the nuances of digital experience and anti-Black digital racism call for prioritization of Black girlhood and critical digital and media studies. As a mechanism where racism is affirmed and enforced, colorism ascribes privileged status to people whose phenotypic features are in closer proximity to whiteness (Rosario et al., 2021). According to Anderson et. al. (2017), Black girls tend to customize avatars that are more aesthetically driven. They choose skin tones based on aesthetics and make avatars that represent themselves (Freeman & Maloney, 2021; Spangenberger et. al., 2019). This preference for aesthetics extends to selecting the skin tone for their avatars. In this context, avatar customization becomes a means of self-expression and personal identity representation in the digital space. By tailoring avatars to their unique aesthetics, Black girls strive to forge virtual identities that mirror their individuality, style, and self-perception. The avatar serves as an extension of their personality, providing a creative outlet for self-expression. However, the limited availability of diverse and inclusive avatar creation tools presents challenges, hindering their ability to find representations that align with their preferences and self-image. This scarcity highlights a broader issue within the tech industry – the underrepresentation and marginalization of diverse groups in design and development processes. It emphasizes the crucial need for inclusive design and equitable representation to ensure that technology, particularly avatar creation tools, addresses the preferences and needs of all users, irrespective of their race, ethnicity, or background. Additionally, this sheds light on the potential impact on the self-esteem and self-identity of Black girls when faced with a lack of avatars that resonate with their aesthetic preferences. The absence of diverse representations may unintentionally reinforce harmful stereotypes and perpetuate the notion that certain aesthetic features are more socially acceptable or desirable than others.

As we journey through the evolution of avatars and representation, new media technologies have found patterns in a perpetuated colorist reality that has limited skin tone options for darker-complected individuals to accurately represent themselves online. Williams (2019) conducted a study that captured the difficulty of a Black femme gamer to capture their in real life (IRL) hairstyles in digital spaces because of system designers' limited conceptions of Black hair. This lack of choice in digital representation leads to users embodying certain traits in

virtual spaces causing the erasure of the nuances of Blackness in virtual spaces, inevitably causing a digital divide. Black people are excluded from progress forward and find themselves playing catch-up to virtual life. Their presence in virtual spaces remains managed by an industry that does not envision Black people as the primary users of technology (Williams, 2019). There are about three brown skin tone options that look like they were badly colored compared to default white characters when trying to decide how to accurately represent ourselves as Black girls online (Williams, 2019). In this instance, 'badly colored' means the quality and accuracy of the available brown skin tone options for avatars in digital spaces are not well-executed. The representation of brown skin tones in these avatars lacks realism, depth, and proper shading. The colors chosen for these skin tones do not adequately capture the diversity and complexity of real-world skin tones for individuals with darker complexions. Black girls are experts at learning to comply with white standards in order to survive in society. This includes how they choose to wear their hair in virtual spaces. This lack of choice and exclusion leads to the erasure of nuances of Blackness in virtual spaces, with projections of whiteness that reinforce the US racial structure in the digital space by alluding to the creation of white personae via avatars and subjects the perspectives of Black folx to be misrepresented (Nishi et. al., 2015).

As new media technologies are inundated with digital discourses that inform, socialize, and have implications on identity construction, the digital nativity of Black girls in negotiation with their online experiences is scarcely foregrounded in vital contemporary research across the interdisciplinary fields of Black girlhood. This becomes a further priority as colorism has been sustained in media agendas that position darker-toned skin as inferior to lighter tones (Abrams et al., 2020), directly altering the lived experiences of Black girls. Acknowledging Black girls' digital potentiality measured within these types of anti-Black agendas calls for a foregrounding of contemporary scholarship aiming to disrupt the hierarchy of personhood based on color. More directly, this paper aims to contribute to that scholarship by centering digital resistance that aims to counter digital anti-Black racism that positions Black girls' bodies as sites of assault in online spaces. Through a digital collaborative ethnography, this manuscript works towards conceptualizing digital movements of resistance to colorist messages and digital anti-Blackness on Black girls explicitly. As digital tools continue to be integrated within everyday life, the relationality of digital Black girlhood to personhood in the digital realm must expose the controlling images of anti-Black digital messages that inform how Black girls are treated, and most importantly, how Black girls treat and see themselves. Through our review, we aim to center the mass consumability of digital media movements toward disrupting colorist messaging in digital Black Girlhoods and to capture the implications of those realities across our collective digital ethnographic reflections in charting new media technology as members across different generations. Recognizing the impacts of digital colorism uncovers the deniability of the stripped humanity of digitally native Black girls that measure likeability, intelligence, and beauty against proximity to whiteness in online spaces. This paper also brings awareness and visibility to how digital movements of resistance are forming as a critical counter to disengage and disrupt this subtle, yet powerful form of digital anti-Black racism.

Stereotype Threat, Colorism, and Body Politic in Black Girl Cyberspace

The digital participation and representation of Black women and girls globally illustrate that Black women and girls face unique challenges in digital spaces. These digital challenges influence the social identities that Black women and girls embody, conditioning their

negotiation of digital spaces. The negotiation of stereotypes in digital spaces can be linked to Steele's (1997) research on stereotype threat, defined as the socio-psychological or mental picture of oneself from the oppressors' perspective. Essentially, the stereotype threat in conversation with digital Black feminism details the participation of Black women and girls in digital spaces, especially social media platforms where Black women and girls face the most dehumanizing stereotypes. Racial stereotypes against Black women are powerful ideological tools that constitute marginalization against minority groups overall (Bessenoff, 2006; Collins, 2009; Poran, 2006)). Stereotype threat reiterates the psychological characteristics of digital participation by Black women and girls, infiltrating their alternative digital lens.
Black women's and girls' bodies have historically been sites of political and social harm, influencing their lived experiences and digital identities. Eurocentric beauty standards and body images dominate media and popular culture, causing Black women's bodies to be habitually objectified and disvalued. For Black girls developing under oppressive politics Black women and girls agency through digital platforms demonstrates that although Black women may not identify with white depictions of beauty, they actively disengaged with these stereotypical images to protect themselves from stereotype threat (Poran, 2006).

Digital stereotype threat can manifest through situational cues (Stelle, 1997) grounded in proximity to whiteness permeating online spaces. For Black women specifically, stereotype threat can present online as anti-Black rhetoric coupled with white definitions of femininity utilized to suppress Black women and girls in digital spaces. Although many scholars have argued that stereotype threat is visible across race and gender classifications (Kafai et. al., 2010; Nishi et. al., 2015), the critical component is that Black women as a group face a particular set of stereotypes that disvalue them as a racial and gendered group (Collins, 2010). To resist stereotype threat, many Black women and girls devise an alternative online identity, typically measured in proximity to white ways of being (Jacobs, 2016). This measuring can show up in digital spaces physically-colorism, texturism, beauty filters-and ideologically-hypersexualization, virtual code-switching, appearance- influencing how digital perceptions of our character and personalities.

Colorism, as a manifestation of anti-Blackness, functions as a mechanism to uphold the subordination of Black women and girls in terms of beauty and desirability. Within the digital age, the identification of oneself as a Black woman exposes individuals to simultaneous evaluation against colorist ideals of femininity and beauty. Digital colorism is an extensively prevalent social phenomenon, observable across various social media platforms, online advertising, and image editing, wherein a preference for lighter skin tones is perpetuated (Childs, 2022). This colorist paradigm permeates the participation of Black women and girls in digital spaces, reinforcing the entrenched nature of anti-Blackness within the digital landscape. Moreover, the proximity to whiteness achieved through lighter skin tones intensifies the potential for cultural and social capital, while simultaneously marginalizing those with darker complexions online (Childs, 2022; Collins, 2010; Steele, 2022). The proliferation of colorist imagery not only impacts the digital engagement of Black women but also inflicts harm upon their self-esteem and mental well-being, causing Black women to present themselves with lighter skin tones via image alternating or avatar creation digital tools.

However, the presentation of an alternative self can be disadvantageous to resisting anti-Black racism within digital platforms. For example, there is a lack of representation when it comes to Black folks hair choices for emojis, bitmojis, memojis, and avatars. The choices are often

comical including and often limited to “spherical afros, straight-back cornrows, [and] cylinder ponytailed locs” (Williams, 2019). Hair styling is significant to Black cultural identity and Black girlhood. Black girls have used hair to express cultural pride and a sense of community. Black girls would like to be able to choose a hairstyle for their avatar that they actually wears on their head and not a style created by an algorithm or an application designer with a limited concept of Black hair. This lack of hair diversity in the digital space is simultaneous to IRL policies in schools and in work spaces where Black girls and Black women are told to not wear braids, not wear locs, or straighten their hair in order to be allowed in certain spaces (Williams, 2019). The hairstyles in many virtual spaces today meant for brown skin tone characters represent 70’s styles or hairstyles designed with lighter hue characters in mind. Moreover, many social media algorithms reinforce negative stereotypes, making it difficult for individuals to challenge them (Bassenoff, 2006). Furthermore, because Black women and girls carry stereotype threat into digital spaces, typically this group may pack a light “digital bag” (in the words of Erika Badu), one that strategically avoids negative depictions of Black women through suppressing Black women and girls' digital identities. Nevertheless, the “lightness” of our digital bag as Black women infringes upon our psyche in physical and virtual spaces concurrently.

Avatars, emojis, bitmojis, and memojis have a lack of representation (Anderson et. al., 2017). There are a prescribed set of choices. As a result, people adapt and use the features that are available to them (Williams, 2019). Sometimes to obtain more options, one must either pay or endure a waiting period. Increasing more options comes at a cost to the company, which allows less access for people in a certain population. When customizing an avatar, users may want to adjust the nose shape or lip size to accurately represent themself. Unfortunately, this causes the avatar to look less aesthetically pleasing. The avatar ends up resembling a Blackface caricature instead of having a natural human appearance (Nishi et. al., 2015; Willimas, 2019). Avatar users should have the ability to customize their avatars to have natural appearances, to look like in real life (IRL) Black girls, and not look artificial or even alienated (Spangenberger et. al., 2019). Limited choices in how a person gets to create their virtual self affect a person's representation of who they are or desire to be when participating in the online community (Kafai et. al., 2010). This lack of representation causes Black girls to feel excluded from the creation of avatars that represent them accurately.

The absence of minorities on the Internet was coined as the “digital divide” (Kafai et. al., 2010). Those with access to computers and the Internet and those without access are also referred to as a “participation gap.”This is defined as those who know how to produce and contribute to online content and those who just browse the internet (Kafai et. al., 2010). Black people continue to be excluded from progress and end up playing catch-up in expected virtual life because the people who manage these spaces do not envision Black people as primary users of technology, especially Black women, and those who identify as such (Williams, 2019). Research has revealed that these technology spaces do not promote inclusivity but instead target their virtual representation toward men and boys (Anderson et. al., 2017). As a result, digital spaces are derived from a white (male) user experience and when Blackness is introduced, it results in inauthentic cultural forms (Williams, 2019). Black girls have the option of choosing between yellow face or Black face, inaccurate skin tones.

Digital Black Feminism, Online Collaborative Ethnography, and Black Girlhood

Digital Black feminism is an extension of Black feminist thought in negotiation with digital spaces and Black women and girls' experiences. Through the consideration of racialized and gendered digital discourses and culture, digital Black feminism extends inquiry space in the past, present, and future of technology (Steele, 2021). As research and scholarship continue to respond to this much-needed space of inquiry, more opportunities are created to acknowledge the continued evolution of Black cyberculture and digital Black feminism to critically document Black women and girls' impact on the histories of this cultural infrastructure. In this way, emerging scholarship creates avenues as sites of Black digital expression and the extension of Black feminist technoculture. These sites of resistance are further contextualized through what Steele (2021), terms principles of digital Black feminisms, as possibilities in digital spaces are linked to principles of agency, the right to self-identify, gender nonbinary spaces of discourse, complicated allegiances, and the dialectic of self and community interests.

As a methodological and theoretical tool, digital Black feminism gives language both through theory and method for the experiences of Black girls to be centered and explored and for Black feminism theoretically to provide a lens for highlighting the spaces wherein Black girls find safety, platform, and resistance. A resistance that disrupts the centrality of whiteness that the digital space creates capacity for. Utilizing digital collaborative methodology, this work centers reflective collaborations within the research process to center, precondition, and shape the research design. As an online research method, digital collaborative ethnography adapts ethnographic methodology to give language for studying community and cultural dynamics across new media technology. This research approach creates space for consideration of computer-mediated interactions both internally and externally for individuals who are charting these virtual spaces. Ethnographies of online cultures and communities extend ethnographic study to settings where interactions are technologically mediated. Our digital collaborative ethnography captures both our individual and collective memory work (Dillard, 2008) in our digital negotiations with new media technologies and the communities and spaces in which we negotiate, work, study, and exist in engagement with others within real, everyday lives. This paper aims to capture experiences across both the physical and digital space. It builds the capacity for individual and collaborative relationships that center our ethnographic social experiences both separately and in conversation with one another.

Findings: Our Stories, Our Avatars

Kenesma D. John

Reflecting on the curation of my memoji (See Appendix A, *Figure 1.1*), bitmoji (*Figure 1.2*), and avatar (*Figure 1.3*), I realize there are different options for creating digital avatars of myself, but none of them really capture who I am. Each of the characters is "supposed" to look like me, but I don't feel like any of them accurately represent me. While I think the glasses in all three representations, and my hair in the Memoji (*Figure 1.1*) and Bitmoji (*Figure 1.2*), are on point, the rest of the features just don't match up.

When the yellow skin tone emojis first came out, I didn't fully understand that they were rooted in white supremacy until other options became available. I realized that the creators didn't choose the yellow tone because nobody's skin tone is actually yellow, but because it was seen as closer to whiteness. As soon as the option became available, I switched all my keyboards to

represent the second-to-last option, a brown-skinned tone that was right in the middle of the other brown tones. When Bitmojis became popular in 2014, I initially thought they were fun and enjoyed the idea of creating a character that looked like me. However, I could never quite figure out how to make my Bitmoji (*Figure 1.2*) look exactly like me. My hope was that one day there would be an option to upload a photo and have the Bitmoji created for me. I was never quite satisfied with the final result of my own creations of digital representations.

When I switched from Android to Apple in 2022, I was excited to try the Memoji feature and create a character that looked like me. While it was nostalgic to revisit the process, my character still doesn't look quite like me. The avatar options on Facebook and Instagram also intrigued me, and I thought that Meta would definitely know how to create an avatar that looks like me. Unfortunately, out of all three representations, my avatar (*Figure 1.3*) is the one that looks the least like me. At this point, I don't even use it. I find it frustrating that none of these options for creating digital avatars accurately represent me. It's a reminder that we still have a long way to go in terms of representation and inclusivity in our digital media.

Taryn T.C. Brown

In terms of generational experiences, my initiation into the digital realm aligns with the transformative evolution of cyberculture and digital expression over the last three decades. Facebook emerged during my college years, representing a simpler version compared to the sophisticated technologies available today. At that time, my focus wasn't deeply rooted in understanding how these virtual self-representations authentically mirrored the internal struggles and dialogues I grappled with regarding elements of my body politic, such as hair, skin tone, and body type. What captivated me more was the opportunity to establish connections in virtual spaces with individuals from diverse backgrounds. During these early years, digital expression was characterized less by the creation of personalized avatars and more by a diverse array of virtual imagery, language, and visuals that vividly brought forth different facets of one's identity. This trend was particularly pronounced on platforms like MySpace and BlackPlanet, and it did not permeate digital identity and representation to the extent that I observe in the present day.

As I reflect on my experiences with digital self-representations, I recognize a history of internal struggles shaped by societal comments like "You're so pretty for a dark-skinned girl." These remarks fueled my challenges in navigating perceptions of self and the complexion of my skin. Additionally, my identity as a Zimbabwean often marked me as culturally different, leading to feelings of being an outsider among my peers. The advent of the digital era provided a platform for confronting these aspects of myself, allowing me the agency to deliberate on how I wanted to portray and present the reflection staring back at me in the mirror.

As I've matured, these facets of my identity have become even more intricate. While gaining confidence in the richness of my complexion, I've grappled with other dimensions of the body politic prompted by avatars, bitmojis, and memojis. Although technological advancements have broadened opportunities, I question the implications of internalizing the reality that essential aspects of oneself are often relegated to the 3rd, 4th, or 5th options in digital spaces. Recognizing this tension prompts a critical examination of the progress in Black cyberculture. While we pioneer advancements, we must also acknowledge the complex

interplay that shapes digital identity development and virtual spaces. Deliberating on these intentional questions represents a crucial step forward in navigating the complexities of digital negotiations, with far-reaching implications for racial identity development and socialization.

Ebonie S. Bennett

Upon reflection on the construction of my digital identity in physical and ideological forms, such as emojis, bitmojis, memojis, and avatars; it is evident that the images presented above do not necessarily reflect my true self. Rather, they depict how I would like to be perceived in an oppressive society that devalues Blackness and Black women specifically. As a Black woman navigating digital platforms through a raced and gendered lens, the presented images are heavily influenced by societal stereotypes and biases that have not only influenced my digital participation but also my internal sense of self.

My digital ethnographic research was conducted through a comparative analysis of my digital identities across various emoticon platforms. Through this analysis, the emoji shift from yellow skin to diverse skin tones emerged as a reflection of the attempt made by technology to cater to the diverse identities of its users. However, it should be noted that upon the initial release of diverse skin tone options by Apple in 2015, the color shades offered for darker skin tones were extremely limited. As a researcher and a user, I vividly recall that the darkest available skin tone was at least three to four shades lighter than my actual skin tone. While additional darker skin tones were released in the following months or years, I remain uncertain as to whether my chosen skin tone for my emoji accurately represents my skin color as I would perceive it.

Additionally, the bitmoji and memoji created in 2019 and 2018, respectively, were compared with the most recent Facebook (2021) avatar. The analysis revealed that the current avatar, unlike the previous ones, does not have an overtly friendly smile. This is significant because it aligns with stereotypical depictions of Black women as angry and unapproachable. It is also important to note that the 2021 avatar was available post-Covid, a time after much symbolic activism in mainstream and digital media spaces occurred. An extensive choice of skin color, body type, and physical features are available on the Facebook Avatar (2021) platform compared to the bitmoji (2019) and memoji (2018) platforms.

Moreover, the analysis highlighted the impact of physical stereotypes on the creation of digital emojis. Specifically, the most recent avatar features a darker skin complexion and a braided hairstyle, which contrasts with the straight hair depicted in the previous avatars. The physique of my avatar can also be compared with previous emoticons, demonstrating fuller hips, larger lips, and larger stature. Such findings demonstrate how digital stereotype threat contributes to the perceived digital self, thereby perpetuating anti-Black digital racism and attacks on Black women's bodies.

However, my digital ethnography also underscored the potential for agency among Black women and girls in digital spaces. Through a conscious effort to create accurate representations of themselves, individuals can resist the impact of societal biases on their digital identities. The Facebook avatar (2021), although not exact, is an enhanced version of my digital self that I could recognize. Thus, the present study contributes to the growing body of literature on the

intersection of race, gender, and technology; emphasizing the importance of recognizing and addressing digital racism for Black women and girls.

Results

Using our own positionalities and the Five Principles of Digital Black Feminism (Steele, 2022) we found similarities in our experiences. The themes that emerged are self-perception, authentic representation, societal pressures, and self vs. community. These themes helped us to capture the negotiations of digital representation online.

Self-Perception: Prioritization of Agency

The theme of self-perception aligned with one of the Five Principles of Digital Black feminism, the prioritization of agency. This principle recognizes the agency Black girls and Black women have in shaping their own narratives and experiences in online spaces. This also includes giving Black girls and Black women the tools and resources needed to accurately exercise their agency and make meaningful contributions to digital culture. Not having the correct tools to accurately represent ourselves online was seen in ethnographic collective memory work. Ebonie stated, “I vividly recall that the darkest available skin tone was at least three to four shades lighter than my actual skin tone. While additional darker skin tones were released in the following months or years, I remain uncertain whether my emoji's chosen skin tone accurately represents my skin color as I would perceive it.” Ebonie was not given the correct tools to accurately represent her hue of skin color online. There is a need for more hues and not just three options (*Figure 4.1*).

Kenesma also stated how she did not have the correct tools needed to be represented in digital spaces. She expressed, "Do I see myself? Not exactly. Out of all three representations, my avatar is the one that does not look like me the most. At this point, I don’t even use it." The options that are available for bitmojis, memojis, and avatars are not enough for Black girls and Black women to accurately represent themselves online. The lack of options causes these digital representations to not look like us, to the point where we do not use these tools because they were not meant for us.

Black girls and Black women’s agencies should be at the forefront of all digital strategies that are aimed at advancing Black feminist goals. This means that creators must focus on Black women’s resilience, creativity, and resistance in the face of oppression inside and outside the digital realm. Taryrn shared some of her experiences outside the digital realm. She shared, "As someone who grew up with comments like, “Oh you are so pretty to be a dark-skinned girl,” I definitely have struggled with perceptions of self and the hue of skin." This experience is one that is all too familiar to Black girls who are of a darker complexion. Comments like these are heard inside and outside digital spaces. Giving Black girls and Black women the correct tools, like more skin tone options, can empower us to take control of our digital lives and challenge the dominant narrative and power structures that have historically silenced and marginalized us.

Authentic Representation: The Reclamation of the Right to Self-identify

The theme of authentic representation aligned with another one of the Five Principles of Digital Black feminism, the reclamation of the right to self-identify. This principle acknowledges the need for marginalized individuals to reclaim and assert their agency by defining their own

identities. This is accomplished through actively reclaiming their right to self-identify by sharing their experiences on their own terms. When referring to her Bitmoji, Memoji, and Avatar, Ebonie expressed, "...it is evident that the images presented above do not necessarily reflect my true self. Rather, they depict how I would like to be perceived." We have a right to define and represent ourselves authentically online in any capacity that we perceive as fit. The process of self-identification is complex, and multifaceted, and should not be dictated or constrained by societal norms, stereotypes, or oppressive structures.

Kenesma expressed the immediate change she made when there were more emoji options available. She said, "I immediately changed all my keyboards to represent the 2nd from the last option, brown-skinned, not too light and not too dark but right in the middle." Kenesma was excited to have more options to express her identity in the digital world. She felt as if she could reclaim the power dynamics that have historically controlled and limited our identities. She felt as if she had autonomy in shaping her identity.

Even with forward movement in the digital space, there is so much more that needs to be done. Taryrn reminded us, "... [that] although in the movement forward in digital space for what we can do as Black folx leading our own advancement in Black cyberculture, we must also still think about the true interplay that exists for how we think through digital identity development and virtual spaces." Yes, we are able to represent ourselves authentically, to a certain extent, without external interference or distortion, but we still need to understand digital identity development. With the ability to resist oppressive narratives and assert our own agency, how does this play a role in Black girls' digital identity development?

Societal Pressures: Creation of Complicated Allegiances

The theme of societal pressures aligned with another one of the Five Principles of Digital Black feminism, the creation of complicated allegiances. This principle focuses on the complexity of political and social affiliations due to the intersections of forms of oppression and privilege Black girls and Black women face. This requires the recognition of the diversity of Black girls and Black women's experiences and perspectives. Taryrn expressed how she sometimes had to state comments when taking a picture due to the color hue of her skin. She stated, "It makes me think of, prompting folx to make sure I have good lighting when we just snap a picture, or noticing if a space might naturally be just too dark to capture an image." This aligns with the need to engage in uncomfortable conversations in order to advance shared goals. People who do not share the same skin tone as Taryrn may not understand the importance of good lighting. Black girls and Black women's experiences are shaped by race, gender, class, sexuality, and ability. This means we have different experiences in all aspects of our lives due to our intersecting identities. It is important to not only center our voices but listen also within digital cultures.

There was one question Taryrn wanted us to think through when it came to societal pressures and the creation of complicated allegiances. She expressed, "How can we see youth thinking through the decisions they make or not in the selection of who they are?" Teens are already pressured by society to meet certain expectations and norms imposed on them. There is now added pressure in digital spaces to create and present a certain digital identity through customizable digital representation. Societal pressure involves the expectation to create memojis, bitmojis, and avatars that align with social norms, trends, and/or idealized versions

of oneself. Encouraging digital literacy and promoting authentic self-expression in digital spaces can help mitigate the negative effects of societal pressure and foster a healthier online environment. We can work to create a more inclusive and effective digital space.

Self vs. Community

The theme self vs. community aligned with another one of the Five Principles of Digital Black feminism, the Insertion of a dialectic of self and community interests that are shaped by the affordances of the platform in which they emerge. This principle refers to the navigation of the interplay between individual self-interest and collective community interests within digital platforms. Each digital platform has distinct affordances, functionalities, and dynamics that shape the interactions of users. It also influences how individuals express themselves within online communities. Although individuals have their own interests, perspectives, and goals, they are also part of a broader community. As a result, Black girls and Black women navigate this by balancing their own personal objectives with the goals and needs of the larger community.

One goal of the community is to not give in to stereotypes. Ebonie explained how her digital representation reflected the stereotypical depiction that Black women are angry. She explained, “The analysis revealed that the current avatar, unlike the previous ones, does not have an overtly friendly smile. This is significant because it aligns with stereotypical depictions of Black women as angry and unapproachable.” Black folx are aware of how they are depicted online. Having an avatar that represents a negative stereotype of Black women can have a negative effect on the community, continue oppressive narratives in digital spaces, and set back progress on the empowerment of Black women.

Even with community goals, there are personal goals that need to be highlighted too. Taryrn expressed, "I don’t think at the time I was so invested in how these virtual representations of self truly did actualize some of the internal struggles and conversations I was negotiating with aspects of my body politic (hair, skin tone, body type)." Black girls and Black women can strategically use digital spaces to connect with like-minded individuals. They can use these platforms to foster dialogues, share resources, and promote well-being. They can also critically evaluate and challenge the limitations and potential harms of the platform. For example, these visual representations of self can promote negotiations with aspects of body politic that can perpetuate systemic biases and online harassment which can then require navigating online spaces with caution through self-protection and community support.

Limitations and Recommendation

Understanding the implications of evolving Black representation in digital spaces is crucial for comprehending the potential impact on Black girlhood and shaping more inclusive and equitable digital environments. Black women and girls engage in various forms of digital resistance. They actively challenge and disrupt the prevailing narratives by altering codes, modifying avatars, and creating their own digital content that celebrates and embraces diverse expressions of Blackness. Independent users play a crucial role in reshaping the digital landscape, pushing back against colorist messaging, and advocating for more inclusive representations. However, societal beauty standards, which prioritize lighter skin tones over darker ones, continue to influence the self-esteem and self-perception of Black women and

girls in both real-life and digital contexts. While we investigated the internal processing of how Black women view themselves and the tendency to create representations that deviate from their actual physical appearances; it may be beneficial to conduct a similar study highlighting the perspectives of Black girls.

This paper highlights the significance of critical digital and media studies in understanding and transforming the experiences of Black girls in the digital age. By examining the role of avatars, digital resistance strategies, and the impact of independent users and Black computer programmers, it emphasizes the need to disrupt colorist messaging and redefine representation. Additionally, it explores the complexities of Black girls' self-perception in digital spaces, interrogating the influence of digital nativity and societal beauty standards. Moreover, the paper considers the evolution of Black representation in AI and avatars, raising questions about the future trajectory of Black girlhood in digital contexts. Ultimately, it advocates for a more inclusive and empowering digital landscape that recognizes and celebrates the diversity and agency of Black girls.

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Ebonie S. Bennett (Author 3): is a 4th year Ph.D. Candidate studying Curriculum and Instruction at the University of Florida. Ebonie's research highlights anti-blackness in Education through narrative work. Ebonie aims to uplift Black educational futures through her scholarship and work with Black youth.

Appendix A

K. John Digital Representation

Figure 1.1 K. John Memoji

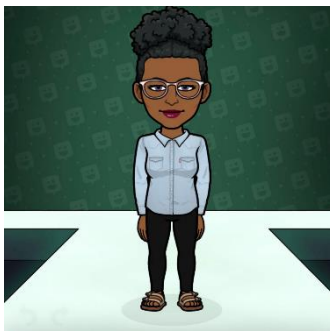

Figure 1.2 K. John Bitmoji

Figure 1.3 K. John Avatar

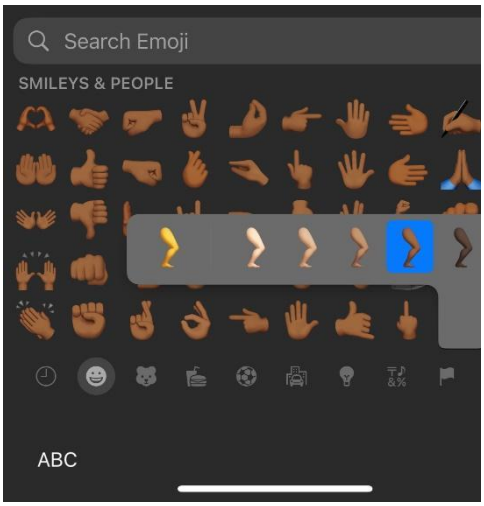

Figure 4.1 Emoji Skin Tone Options

Appendix B

T. Brown Digital Representation

Figure 2.1 T. Brown Avatar

Figure 2.2 T. Brown Bitmoji

Figure 2.3 T. Brown Memoji

Appendix C

E. Bennett Digital Representation

Figure 3.1 E. Bennett Bitmoji

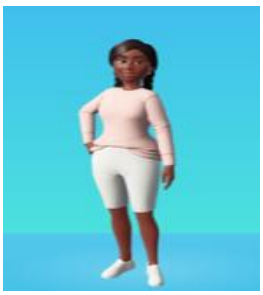

Figure 3.2 E. Bennett Avatar

Figure 3.3 E. Bennett Memoji

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