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Ann Gaudino, Ed.D. Editor-in-Chief
William F. Hoge, Assistant

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In support of our mission, we provide assistance with writing and formatting in English to international writers who seek our assistance with preparing their manuscripts. There are no fees to submit or publish manuscripts so that cost will never be a barrier. Typeset and graphics are intentionally simple in order that the journal can be more easily accessed on a variety of devices worldwide to fulfill the mission of the journal.

I am pleased to share that the United States Department of Education Institute of Education Sciences indexes all articles published in this journal on its ERIC database.

I hope that the practices discussed in this journal will be helpful to you, our readers.

Ann C. Gaudino, Ed.D., Founder and Editor-in-Chief
eejeditor@gmail.com

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Effects of Anticipation Guide Use on Visual Attention Distribution in a Multimedia Environment: An Eye Tracking Study

Natercia Valle, Pavlo Antonenko, Jiahui Wang, and Wenjing Luo

Abstract

Anticipation Guides (AGs) help learners to activate prior knowledge before an instructional unit. As a pre-learning strategy, AGs motivate learners to explore learning materials by challenging, activating, or corroborating their prior knowledge and predictions about a subject. While AGs have mostly been used in reading instruction, in this study, we evaluated the extent to which their use can influence visual attention distribution and learning in a multimedia environment. Eye tracking data from 17 participants randomly assigned to a treatment (with AG) or control group (without AG) demonstrated a significant difference in visual attention distribution but not on learning outcomes. Learners who used the AG exhibited larger numbers of transitions between text and images on the screen. The relevance of this study is two-fold: a) it contributes to the literature on anticipation guides as a learning strategy to activate prior knowledge; and b) it contributes to the literature on eye tracking methodology to support research on allocation of visual attention distribution in a multimedia learning environment.

Keywords: Anticipation guide, multimedia environment, eye tracking methodology, visual attention distribution

Natercia Valle is a Research Assistant in the College of Education, University of Florida, Gainesville. She can be reached at nvalle@ufl.edu

Pavlo Antonenko is an Associate Professor in the College of Education, University of Florida, Gainesville. He can be reached at p.antonenko@coe.ufl.edu

Jiahui Wang is an Assistant Professor in the College of Education, Health and Human Services, Kent State University. She can be reached at jwang79@kent.edu

Wenjing Luo is an Adjunct Instructor in the College of Education, University of Florida, Gainesville. He can be reached at wluo@ufl.edu

With the increasing number of online courses for educational purposes (Allen & Seaman, 2010), including for professional development, it is necessary to identify strategies that will maximize learning within this context. Moreover, while different aspects of multimedia learning such as the cueing effect (Jamet, 2014), spatial contiguity effect (Johnson & Mayer, 2012), and color coding (Ozcelik, Karakus, Kursun & Cagiltay, 2009) have been studied with the application of eye tracking technology, to our knowledge, none of these aspects have addressed the use of anticipation guides (AGs) specifically.

Multimedia learning materials are used extensively in K-12 and higher education, along with corporate settings and professional development. The multimedia learning environment used in this study was a video used in a professional development module on “setting up the learning environment” created by Early Learning Florida (ELF), a group that helps early learning professionals in the state of Florida to increase their knowledge about child development and classroom management. The video features a main instructor and professionals sharing their experiences presented as a side frame or in the entire frame, text-based content in the form of short bulleted lists, and supporting images (e.g., an image of a classroom setup). The multimedia learning materials follow the guidelines provided by the Cognitive Theory of Multimedia Learning (Mayer, 2005, Mayer, 2014; Mayer & Moreno, 2003) and feature adequate spatial and temporal contiguity, use of signaling, personalization (conversational tone), as well as audio and visual modalities that support each other for enhanced dual channel processing (Paivio, 1990).

Although the ELF environment was designed to support learners’ cognitive processes, the premise of this study was that the integration of knowledge activation strategies in the facilitation of these materials could further enhance their benefits (Pressley, Wood, Woloshyn, Martin, King, & Menke, 1992). Therefore, this study not only contributes to the body of research on knowledge activation strategies (de Boer, Kommers, de Brock &

Tolboom, 2016; Machiels-Bongaerts, Schmidt, & Boshuizen, 1993; Spires & Donley, 1998; Tarchi, 2015; Wetzels, Kester & Van Merriënboer, 2011), but it also offers insights on application of eye tracking methodology in the context of a multimedia learning environment, offering evidence-based information on learners' visual attention distribution via eye tracking data.

Anticipation Guides

Anticipation guides (AGs) have been described as a pre-learning (metacognitive) strategy that can be used to help learners set goals and expectations for learning a topic and stimulate planning and monitoring of cognition (Duffelmeyer, 1994; Kozen, Murray, & Windell, 2006). This strategy consists of providing learners with a template that contains true and false statements pertaining to a new topic that learners are asked to "agree" or disagree" with. Alternatively, learners may be asked to identify which statements are true or false. AG is a promising strategy because it can activate and challenge learners' prior knowledge, perceptions, and possible misconceptions regarding the topics presented (Duffelmeyer & Baum, 1992). According to Duffelmeyer (1994), effective AGs forecast major ideas, are general in scope, and challenge readers' beliefs.

In the standard implementation of AG, a follow-up is usually employed after learners interact with the learning materials to stimulate reflection on what was learned relative to what had already been known about the topic; thus, the follow-up form provides learners with an opportunity to compare their initial (mis)conceptions to their understandings after exploring the content. AG and AG follow-ups are virtually equal, the only difference between them being the addition of space for comments and reflection in the AG follow-up. We adopted the standard implementation of AGs for this study; therefore, when we use the term AGs as the intervention, we are implying its combination with the AG follow-up.

In a multimedia learning environment, AGs can activate relevant schemas in prior knowledge before browsing a new instructional unit. Thus, this study investigated how the use of an AG influenced visual attention distribution and learning outcomes; however, unlike prior studies on the effects of AGs on cognition and learning that have mostly focused on reading traditional linear texts (Duffelmeyer, 1994; Readence, 1992; Yell, Scheurman & Reynolds, 2004, Hairrell, Simmons, Swanson, Edmonds, Vaughn & Rupley, 2011), this study was conducted in an authentic context of a video-based multimedia learning environment (Mayer, 2005) used for professional development purposes.

Visual Attention Distribution and Eye Tracking Methodology

Prior to the application of eye tracking methodology to investigate visual attention distribution in multimedia learning environments, most studies were based on learning test results, time on task, or cognitive load measures after learners interacted with the learning material. These studies missed important information on what aspects of the learning materials learners actually attended to and which cognitive processes these materials incited (Sungkur, Antoaroo & Beeharry, 2016; van Gog & Scheiter, 2010).

Mayer (2010, p. 167) describes the contribution of studies with eye tracking methodology by emphasizing how these studies uncover perceptual processing related to learning and go beyond the “what works” and “when it works” questions by addressing the question of “how” it happens; that is, how learning occurs. For instance, Johnson and Mayer (2012) provided a thorough discussion of the spatial contiguity effect based on three experiments with text and graphics: integrated vs. separated condition (Experiment 1); integrated with label vs. separated condition (Experiment 2); and integrated vs. legend condition (Experiment 3). They first define the theoretical framework, Cognitive Theory of Multimedia Learning, (CTML) and CTML’s spatial contiguity principle, followed by the discussion of the results in terms of their contribution to basic research, education, and

existing theories on processes of selecting and cognition during learning. Their results corroborated the findings of previous studies on the contiguity effect in regard to text preference in multimedia presentations. There were more fixations on the text than on the graphics; however, performance on transfer test was statistically significant only in Experiments 1 and 2. This study offers the unique advantage of an evidence-based approach through the use of eye-tracking technology, which can generate insights on how the presentation of instructional materials can influence the integration of information during learning (Johnson & Mayer, 2012). The authors also mention some limitations related to the use of eye-tracking technology, such as problems with calibration and spatial constraints for the creation of areas of interest (AOI), which influenced the design of the learning material in one of the experiments.

Jamet (2014) employed eye-tracking methodology to evaluate visual attention distribution in relation to the cueing effect. This study examined how cueing can influence retention and knowledge transfer in a multimedia learning environment. Four hypotheses related to the use of cueing on static learning material were explored: H1. cueing improves retention, H2. cueing improves transfer, H3. cueing increases fixation duration on relevant information, and H4. cueing increases fixation duration on verbal explanations accompanied by cueing. The study produced mixed results: learning improvement (H1 and H2) was only partially confirmed as the cueing group showed improved retention, but not transfer. A positive relationship between attention and cueing (H3) was confirmed, reducing half the time spent on some non-relevant information such as the progress bar and blank spaces. The contiguous process of visual information when cueing is used (H4) was also confirmed. This study is an important reference for instructional designers and researchers as it can serve as a guide for practical applications of cueing and can generate valuable insights for further investigation on multimedia learning.

Ozcelik and colleagues (2009) also employ eye tracking methodology to examine how color coding influences retention and knowledge transfer. Some of their results demonstrate that color-coded material generated better learning performance, as fixation duration was longer for the group with color-coded material; long fixation was related to cognitive processing of information, but not to the perceived difficulty of the learning material. Their study contributes to the literature on how multimedia design influences learning and the potential of eye-tracking studies to address cognitive processes and attention distribution in learning environments.

Together, these studies represent the potential of employing eye tracking methodology to provide evidence-based insights on attention distribution in computer-based multimedia learning environments. The design of these studies and their findings offered crucial guidelines during the design and implementation of our study as well as during the interpretation of the results.

Methodology

Study Design

This study employed a between-subjects quasi-experimental design consisting of two groups: with and without anticipation guide (AG). Use of AG was the independent variable in this study. There were two dependent variables: learning and visual attention distribution. This study was designed to explore how the use of an anticipation guide (AG) influences visual attention distribution (e.g., help focus learners' attention on the most salient aspects of instruction) and learning.

Understanding learning in a multimedia environment requires the use of a complex set of measures. The use of visual attention distribution data in addition to learning outcomes in this study was required to generate important insights into the processes of cognition and learning with multimedia. This is an important distinction from

focusing merely on learning outcomes, which is a common practice in educational research. Therefore, this study investigates learning with AG in a multimedia environment using traditional *product* measures such as learning tests; however, it also integrates *process* measures of attention and cognition afforded by eye tracking.

Eye Tracking Data

Multimedia stimuli and measures were displayed on an external 20-inch flat panel monitor viewed at a 55-cm distance, with a resolution of 1600 by 900 pixels and a refresh rate of 60 Hz. Eye-tracking data was collected using an Eyelink 1000 Plus system (SR Research, Ontario, Canada) using a desktop-mount (Fig. 1). Participants used a chinrest (SR-HDR) with a forehead bar to minimize head movement. Eyelink's Screen Recorder software was used to simultaneously capture locus of participants' gaze while recording screen capture videos, at a sampling rate of 1000 Hz.



Fig. 1 Eye tracking set up in the lab

Visual attention distribution was operationalized using the following eye tracking data: number of fixations, duration of fixations, and transitions between areas of interest. Areas of interest (AOIs) were regions in the instructional video that were of special interest to this study. AOI 1 was comprised of text presented at several points during the video on one

side of the screen, and AOI 2 was comprised of images or video presented on the other side of the screen next to AOI 1 (Fig. 2).

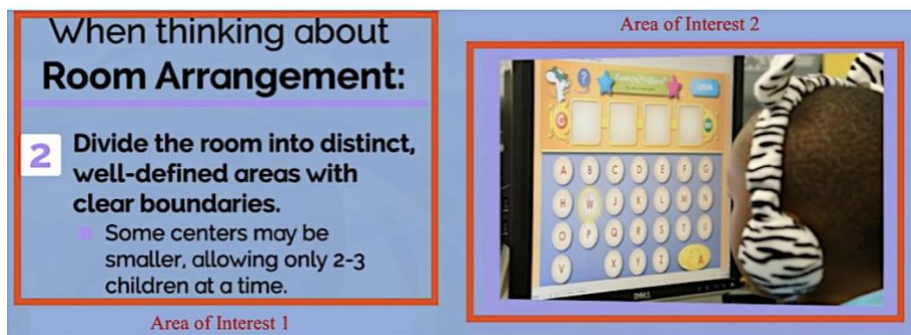


Fig. 2 Screenshot of the instructional video showing AOI 1 (text) and AOI 2 (image or video of the classroom)

The following definitions were based on the user documentation and output generated by Eyelink 1000 Plus system (SR Research, Ontario, Canada):

- Fixation %: percentage of all fixations falling in the current interest area.
- Fixation count: total fixations falling in the interest area.
- Fixation count between areas of interest (Transitions): number of fixations (fixation N) which started in the current row of interest area, with fixation N + fixation_skip_count ending in the current column of interest area, i.e., fixations that started in one AOI and ended in another AOI.
- Fixation duration between areas of interest: summed duration for all fixations (fixation N) which started in the current row of interest area, with fixation N + fixation_skip_count ending in the current column of interest area.

Learning Data

Learning was operationalized via transfer and recall activities. The knowledge transfer test included six multiple-choice questions that were based on a scenario involving a preschool setting (Fig. 3) in which learners had to apply (transfer) the knowledge they had about preschool to a new situation, as prompted by the scenario. Each question had three distractors and one correct response based on the learning content. The scenario and the

knowledge transfer test questions were presented before the cued recall test (fill-in-the-blank questions).

Participant ID

Please read the following scenario and choose the most appropriate option for each question

Suppose you are a preschool teacher with formal training and experience in working with children with special needs. You work in a VPK classroom in a small private school and you are half way through the school year. The curriculum that you follow emphasizes literacy and math skills and your students have access to tablets (e.g., iPad) and a small computer station, which are shared among the different classrooms. Your goal is to prepare the children for kindergarten, giving them the foundation to succeed in school.

One of your students, Mike, has developmental delays, receives speech therapy twice a week and uses a walker to facilitate his mobility. Activities considered simple by his peers such as cutting paper or throwing a ball can be challenging for him because of his less developed coordination, fine and gross motor skills. Unfortunately, Mike's caregivers are not involved in his school activities and do not follow his progress at school.

At times, Mike becomes very frustrated and can be aggressive when people do not understand what he is saying or when he cannot sit in the computer station due to its size and location at a corner of the media center.

The principal decided to host weekly meetings to address activity planning (curriculum) and discuss how some money recently raised by the school would be spent. All teachers, including you, were called to provide inputs on these issues. Some of the questions participants ask you during those meetings are shown below.

Please choose the response that closest represents your position for each question (one response per question):

Fig. 3 Scenario used in the knowledge transfer test

The cued recall test, where learners were asked to remember words and concepts cued by contextual features, was implemented via a fill-in-the-blank format with 10 statements from the learning content. There were statements with one, two, or three missing words, as shown in Fig. 4. The items covered the topics that had not been directly addressed in the knowledge transfer test to mitigate possible priming.

7. As preschool teachers, setting up our space, including creating _____ and establishing routines are some of these components.

8. Provide interesting _____, _____, and _____ toys and activities in the daily curriculum.

9. The purpose of _____ is to provide a space for children to independently choose materials that interest them while practicing emerging skills in various content areas.

10. The dramatic play and block area might be near each other because they encourage _____, while the reading, writing, listening, and computer areas are located near each other for _____.

Fig. 4 Example of statements used in the cued recall activity

Participants

Seventeen participants, between 18 and 61 years old ($M = 29.94$), were randomly assigned to two groups: treatment (AG, $n = 8$) and control (no-AG, $n = 9$). These participants represented the Early Learning Florida target audience: childcare service providers and undergraduate students majoring Early Childhood Education who were 18 years old and over, working in the state of Florida, and were interested in improving their knowledge and skills in working with preschool-age children. The small sample size results from the difficulty in recruiting professionals in the area of early childhood education, as these professionals typically work extensive hours from early in the morning until late in the afternoon.

Protocol

The general protocol followed for data collection included setting up and calibrating the eye tracker, organizing paperwork (e.g., IRB approved informed consent), and organizing video and learning materials prior to the arrival of each participant. Learners in the treatment

(AG) group completed the activities in the following sequence: a) following recommendations for designing and using AGs (Duffelmeyer, 1994), participants in the treatment group were asked to complete an AG on “setting up the learning environment” (Fig. 5) five minutes prior to browsing the multimedia resource on this topic; b) interaction with the learning materials in the multimedia environment, c) knowledge transfer activity, d) cued recall activity, and e) completion of the AG follow-up, (Fig. 6) reflecting on what they learned upon completing the multimedia module. Learners in the control group (without AG) followed the same sequence, aside from the absence of an AG and the AG follow-up. The whole procedure took about 60 minutes for learners in the treatment group and about 40 minutes for learners in the control group.

Participant ID:

Read each statement below. If you believe a statement is true, select the "Agree" column. If you believe that a statement is false, select the "Disagree" column. Be ready to explain your choices.

	Agree	Disagree
1. Children with sensory integration concerns should be allowed to choose which food to eat.	☐	☐
2. Wiggling the furniture is a good way of testing its stability.	☐	☐

Fig. 5 First two statements in the AG. The AG included 10 statements, with five correct statements and five incorrect statements. Participants were asked to “Agree” or “Disagree” with each statement

Participant ID:

Now that you have reviewed the resources on the Early Learning Florida website, please check "Yes" if the information from these resources supports your earlier predictions or check "No" if it does not.

Please use the Comments box to records your thoughts on why or why not your view changed.

	Click to write Column 1		Click to write Column 2
	Agree	Disagree	Comments
1. Children with sensory integration concerns should be allowed to choose which food to eat.	☐	☐	
2. Wiggling the furniture is a good way of testing its stability.	☐	☐	

Fig 6 First two statements in the anticipation guide follow-up that also included space for comments.

Data Analysis

The statistical software R was used to analyze all data in this study. Boxplots were used to represent results and data distribution for the most important aspects of the study such as learning tests and visual attention distribution. Wilcoxon rank-sum test was appropriate for this study due to its small sample and because the normal distribution assumption could not be assumed (Whitlock & Schluter, 2009).

Results

In relation to visual attention distribution, we found a significant difference for the areas of interest 1 (text) and 2 (image). In relation to learning outcomes, no significant differences were found between the experimental groups.

Visual Attention Distribution

We assessed visual attention distribution by analyzing eye tracking data in relation to two areas of interest (AOI): AOI 1 (text) and AOI 2 (the rest of visual content: pictures with

pan effect and video). Specifically, six eye movement were explored: fixation percentage, total fixation count, fixation count between AOIs (transitions), fixation count within AOIs, duration of fixation between AOIs, and duration of fixation within AOIs.

The descriptive statistics related to visual attention distribution data related to AOI 1 (Text) and AOI 2 (Images) are summarized in Tables 1 and 2, respectively. Table 3 shows the results from the two-sample Wilcoxon test used to analyze how the treatment and control groups responded to AOI1 (Text) and 2 (Images). Participants in the treatment (AG) group performed significantly more transitions from text to image ($M = 53$) and from image to text ($M = 51$) than the control group ($M = 35$ and $M = 33$, respectively). Fig. 7 displays screenshots of transitions for two participants. The images were generated by the eye tracker and shows the distribution and number of transitions for individual learners. Red and yellow arrows indicate where the fixations started and ended for participants in the treatment and control groups, respectively.

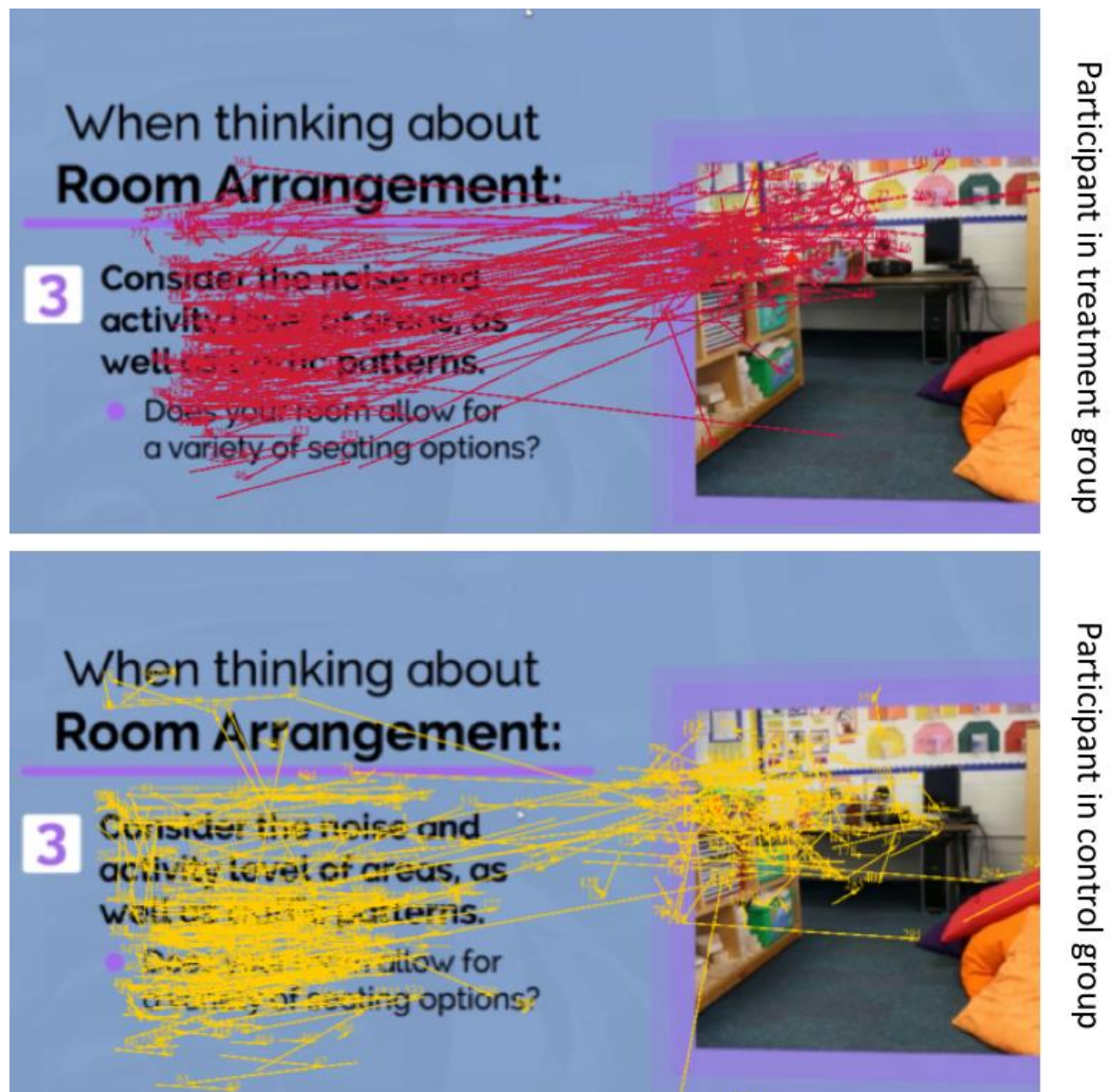


Fig. 7 Exemplars of transitions: top and bottom images show transitions made by participants in the treatment (red arrows) and control (yellow arrows) groups, respectively

Although not a statistically significant difference, AG participants also took longer to fixate their gaze after transitions (Fig. 8). No significant differences were found in relation to fixation count and duration of fixation within AOIs.

Table 1 Descriptive statistics for the visual attention distribution data related to AOI 1 (Text)

Variables	AOI 1: Text			
	<u>AG group</u>		<u>no-AG group</u>	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Fix (%)	0.60	0.04	0.58	0.12
Total fix count	393.67	86.91	344.75	63.21
Fix count within Text	333	83.79	302	59.43
Transitions	53.33	7.66	35.25	5.20
Duration of fix within Text (sec)	66.88	7.34	68.22	18.41
Duration of fix transitions (sec)	14.78	4.18	10.48	3.32

Table 2 Descriptive statistics for the visual attention distribution data related to AOI 2 (Image)

<u>Variables</u>	<u>AOI 2: Image</u>			
	<u>AG group</u>		<u>no-AG group</u>	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Fix (%)	0.35	0.03	0.37	0.13
Total fix count	225.33	30.02	226.37	109.17
Transitions	51.33	6.80	33	6.84
Fix count within Image	157.83	22.57	179.12	111.48
Duration of fix transitions (sec)	10.14	1.61	7.60	2.26
Duration of fix within Image (sec)	45.01	6.20	59.41	26.07

Table 3 Two-sample Wilcoxon test for the visual attention distribution across groups: AOIs 1 (Text) and 2 (Image)

Variables	Text		Image	
	<u>W</u>	<u>p</u>	<u>W</u>	<u>p</u>
Fix %	26	0.852	22	0.852
Total fix count	15	0.282	16	0.345
Fix count within AOI	20	0.662	18.5	0.518
Transitions	0	0.002	0	0.002
Duration of fix within AOI (sec)	30	0.491	36	0.142
Duration of fix transitions (sec)	10	0.081	9	0.059

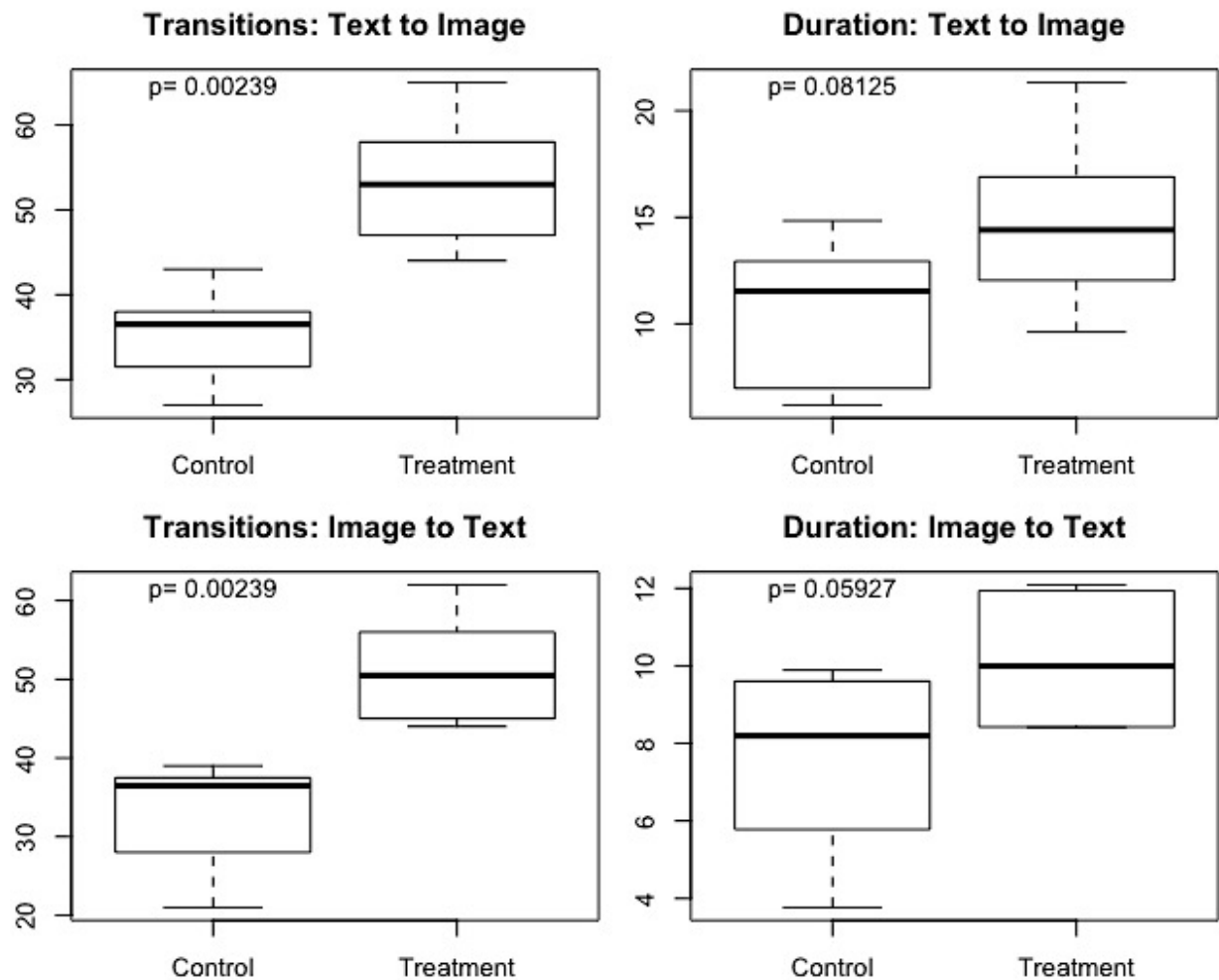


Fig. 8 Transitions from text to image (AOI1 to AOI2) and from image to text (AOI2-AOI1) and their respective fixation duration after transitions (in seconds)

Learning Outcomes

Although the difference in learning outcomes between the anticipation guide (AG) and no-AG groups was not statistically significant ($W = 50.5$, $p = 0.1$), the control group exhibited better performance in the activity related to the use of a scenario (knowledge transfer) ($M = 4.11$, $SD = .78$) compared to the treatment group ($M = 3.37$, $SD = 1.06$).

Discussion

We found a significant difference in the pattern of visual attention distribution (number of transitions) between learners in the treatment and control groups, with learners in the treatment group having a larger number of transitions. This difference could indicate the

occurrence of one of two contrasting cognitive phenomena: optimal or suboptimal integration of the information from both text and image (Fig. 9).

The first explanation relates to the successful mental integration of content (Holsanova, Holmberg & Holmqvist, 2009). This explanation would be further supported if other information such as learning outcomes suggested that learners in the treatment group indeed understood more of the information presented. In this case, the greater number of transitions would indicate a successful cognitive engagement likely prompted by the use of the anticipation guide.

The second explanation relates to a suboptimal use of cognitive resources (Johnson & Mayer, 2012) to integrate the information from images and words. This explanation would be better supported if learning outcomes suggested that learners in the treatment group did not understand the concepts covered despite their attempts (greater number of transitions), which could suggest that the use of the anticipation guide created some case of split attention (Mayer & Moreno, 1998, Sweller, Van Merriënboer, & Paas, 1998). This second outcome would be similar to the findings of Johnson and Mayer (2012), who did not find significant differences for knowledge transfer regardless of the number of transitions between groups. This was a contradiction to their hypothesis that greater integration of words and images would result in higher transfer scores.

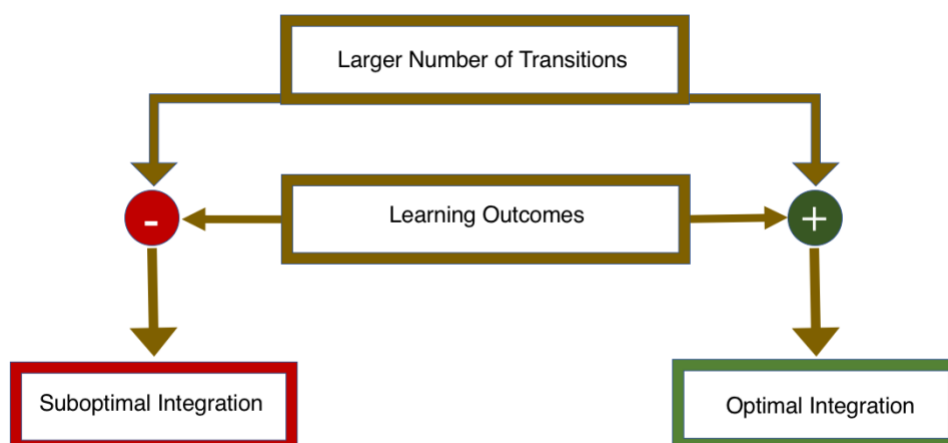


Fig. 9 Possible explanations for differences in visual attention distribution in combination to other supportive information such as learning outcomes

In the absence of differences in learning outcomes, it would be irresponsible to claim either explanation as the underlying reason for the differences in visual attention distribution.

Confirmation bias (Friedrich, 1993) could also be considered as a possible contributor to the differences between groups observed in this study. Confirmation bias occurs in learning situations where learners seek information differently, prioritizing information that supports their initial opinions about the topic or interpreting contrasting information as supporting evidence (Jonas, Schulz-Hardt, Frey & Thelen, 2001; Nickerson, 1998). It is possible that the use of AG in this context, with adult learners practicing in the area of childhood education, may have resulted in confirmation bias in which learners were constantly checking the new learning content (text and images) against the schemata activated by the use of AG.

Conclusion

The differences in visual attention distribution between the treatment (with AG) and control (without AG) groups in this study suggest that the AG did influence how learners interacted with the learning material in the multimedia learning environment; however, the nature of the cognitive processes underlying the visual patterns identified cannot be precisely determined. Although AGs were beneficial in some other contexts (Yell, Scheurman & Reynolds, 2004; and Kozen et al., 2006), the lack of significant differences on learning measures created additional questions regarding possible causes for the difference in allocation of visual attention distribution between both groups in this study. These results may be moderated by the design and implementation of the AG in this study, the small sample size, content difficulty level, and complexity of the multimedia materials. The tentative evidence generated by this exploratory study suggests that this issue needs to be investigated in more detail and with larger samples.

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Examining Preschool Teachers' Beliefs About Writing and the Supports They Provide Children

Joy Myers, Chelsey Bahlmann Bollinger, and Jennfier Mollen

Abstract

This study examines the beliefs and practices, specific to writing, of six preschool teachers using observations, interviews, photographs, and surveys. Gerde, Bingham, and Pendergast's (2015) WRITE protocol was used during observations, allowing researchers to focus on each classroom's writing environment and teachers' use of environmental print, modeling, scaffolding, and independent writing. Findings reveal that although the preschool teachers expressed strong beliefs about the importance of writing in their classrooms, their implementation of practices to support young writers varied. Implications for supporting the writing instruction of young children are discussed as well as the potential use of the WRITE protocol with pre-service and in-service teachers.

Keywords: writing, preschool, pedagogy, teacher beliefs, teacher practices

Joy Myers Ph.D. is an Assistant Professor and the Academic Unit Head of the Early, Elementary, and Literacy Education Department at James Madison University. She can be reached at myersjk@jmu.edu.

Chelsey Bahlmann Bollinger Ph.D. is an Assistant Professor of Language and Literacy Education at James Madison University. She can be reached at bahlmacm@jmu.edu

Jennifer Molen M.Ed. is an elementary educator from Richmond, Virginia. She can be reached at mollenjl@jmu.edu

A significant amount of early literacy instruction focuses primarily on learning to read. As a result, writing instruction may be neglected (Cahill, 2009; Coker et al., 2016). This is problematic because if teachers do not intentionally engage children in early reading and writing strategies these skills will not develop (Copp, Cabell & Tortorelli, 2016; Copple & Bredekamp, 2009; Hall, 2017). Furthermore, researchers have found that children's early writing skills, specifically how they connect oral and written language, are significant predictors of later literacy achievement (Hall, Simpson, Guo & Wang, 2015; Lonigan & Shanahan, 2009). Thus, all children should be given opportunities to engage in developmentally appropriate writing experiences (Watanabe & Hall-Kenyon, 2011).

Writing in Early Childhood Classrooms

Best practices for promoting young children's writing have evolved and will continue to evolve over time. Today, one of the most popular practices is the use of a writing center or writing workshop where children can come together collectively to create co-texts (Kissel & Miller, 2015). Even though young students may not be creating full words or sentences, they are able to convey the meaning of their scribbles, connecting both oral and written communication (Roskos, Christie, & Richgels, 2003). Thus, children's writing development can be impacted by the physical classroom or environment. Research suggests that classrooms should include a variety of environmental print, writing routines, and writing materials to encourage children to use writing during their daily activities and routines (Bingham, Quinn, & Gerde, 2017; Gerde, Bingham, & Wasik, 2012). Teachers also play a role in children's writing development by encouraging children to practice their writing skills and by modeling writing (Quinn, Gerde, & Bingham, 2016). In addition, scaffolding and motivational support from teachers contribute to students' writing development (Kissel & Miller, 2015).

Teacher Writing Beliefs and Actions

As noted above, teachers' practices are instrumental in supporting young children's writing development, but research suggests, so are their beliefs about writing (Foote, Smith, & Ellis, 2004). For the purposes of this study, we define beliefs as the, "knowledge or ideas accepted by an individual as true or as probable" (Evans, Fox, Cremaso & McKinnon, 2004, p. 131). Although some research focusses on a wide scope of beliefs about teaching and preschool, less has traditionally been known about preschool teachers' beliefs specific to content areas (Lee & Ginsburg, 2007).

Two common characteristics that relate to early educators' beliefs and practices are teachers' educational background and their teaching experience (Lynch, 2009). There are mixed findings on the role of educational background in relation to early childhood teacher beliefs and practices, and child outcomes. When teaching experience has been examined in relation to preschool teachers' beliefs, more experience seems to relate positively to different aspects of preschool teachers' literacy beliefs.

What influences teachers' beliefs about writing? Many candidates enter teacher preparation programs with writing anxieties which may translate into a lack of confidence in their teaching of writing (Street & Stang, 2009). Cremin and Oliver (2016) systematically reviewed research from 1990 to 2015 on teachers as writers and found that teachers' beliefs about themselves as writers affected their attitudes. In some instances, this impacted their practice, and included avoidance of writing instruction.

One thing that may influence teachers' beliefs is their knowledge about writing. For example, there may be gaps in teachers' understanding of the role of writing within literacy development and this may impact what they believe and how they implement or incorporate age-appropriate writing instructional practices in early childhood classrooms (Applebee & Langer, 2006; Cress & Holm, 2017; Korth et al., 2017). Others argue that teachers possess

the knowledge about effective instructional strategies to support young writers, like morning message, but these practices have developed into routines in which children are passive observers as teachers write and read the messages aloud (Casbergue, 2017). In some classrooms, teachers express a belief about the importance of writing and provide materials and tools for early writing experiences, however they rarely model or scaffold early writing (Gerde, Bingham, & Pendergast, 2015). This is problematic because according to Tolchinsky (2003), becoming a skilled writer requires focused instruction.

The need to consider the beliefs and actions of preschool teachers specific to writing is critical, given the limited research on this topic (Hall & Grisham-Brown, 2011; Hindman & Wasik, 2008). Thus, the purpose of the current study was to investigate the beliefs and practices, specific to writing, of six preschool teachers through observations, photos, interviews and surveys. The study was guided by the following research questions: 1) What writing supports and teacher/child interactions are observed in six school-based preschool classrooms? and 2) How do preschool teachers' beliefs about writing align with their classroom practice?

Methods

The study took place in an early learning center located in a small city in the southeastern United States. The students and families that make up the learning center's population come from a variety of race, ethnic, and socioeconomic backgrounds, representing the diversity of the city as a refugee resettlement location. A few of the languages spoken in the homes of the students enrolled at the learning center include Spanish, Arabic, Kurdish, Russian, and Korean.

The learning center housed nine classrooms, each with their own teacher and assistant. Many of the teachers co-planned instruction agreeing on weekly themes, center activities, and the daily message to share with students. One classroom accommodated

children with disabilities. Each of the nine teachers were asked to participate in this study. Six teachers agreed. Pseudonyms are used throughout this article to protect participants. Anastasia had 4 years of teaching experience, Amy and Lori 5 years, Kelly 6 years, Adele 7 years and Lydia completed the group with the most teaching experience, 9 years. Each classroom teacher had a bachelor's and a master's degree in early childhood education.

Data Sources

Over a five-month period, the research team which consisted of two early literacy professors and an undergraduate elementary education researcher, collected the following data: semi-structured interviews, observation field notes, photographs, and a final survey. The study began in August as we interviewed each teacher. The interview questions focused on their classroom's demographics, teaching philosophy, curriculum, philosophy of writing, and student work related to writing. The interviews were audio recorded and transcribed for coding purposes.

Each classroom observation lasted between 45 minutes to an hour. Differences in the observation lengths across classrooms was primarily due to variability in each individual classroom schedule and routines. Observation field notes were framed around Gerde et al.'s (2015) Writing Resources and Interactions in Teaching Environments (WRITE) observation protocol. This tool was specifically designed for early childhood classrooms and consists of five sections: Writing Environment, Environmental Print, Teacher Models Writing, Teacher Scaffolds Children's Writing, and Independent Child Writing. Use of this observational tool allows those observing to take a more refined look at how educators are utilizing the five areas to boost and guide writing instruction (Bingham et al., 2017). Other studies, such as that by Gerde, Skibbe, Wright, and Douglas (2019), have used this tool to document writing in early childhood classrooms.

We chose to focus our observations during center and message time since that is when the teachers reported most of the student writing and/or writing instruction occurred. Center time was an hour-long session during which students chose where they wanted to play and explore in the classroom. Some of the centers included dramatic play, a writing center, and a kitchen. Message time included a shared message written by the teacher either on a whiteboard or Promethean Board. During message time, which often followed center time, teachers would write a sentence on the board, usually related to the weekly theme. They then called on students to come up to the board and circle specific letters, count the number of words, etc. During observations we took photographs to support our field notes and further document the five areas of the WRITE protocol.

At the conclusion of the study, we emailed each teacher a follow-up survey asking them about their beliefs about writing, and more specifically to share their beliefs related to the five sections of the WRITE protocol (Writing Environment, Environmental Print, Modeling, Scaffolding, and Independent Writing). The questions were designed to triangulate data between our observation notes, interview data, and the teachers' beliefs. Intentionally, we did not share the WRITE protocol with the teachers at the beginning of the study because we wanted to understand how writing was already occurring in their classrooms.

Data Analysis

To answer the first research question, regarding the writing supports and teacher/child interactions, we merged observation protocols from four of the twenty observations for each teacher. We selected to focus on four days for each teacher based on the days where we observed the most writing. These observations were joined into one table, organized by each teacher, and the WRITE protocol components. Next, teacher behavior and interactions with students specific to writing were coded for frequency. The data was then organized into a

second chart which included representative data examples for each teacher for as many items as applicable on the protocol.

The remaining data sources including interview transcripts and surveys were analyzed qualitatively using constant comparison analysis (Strauss & Corbin, 1990). Since the purpose of the study was to better understand teacher beliefs and practices, the research team first individually coded two of the six interviews using these a priori codes. We then met to discuss discrepancies. Next, the research team compared the interview and survey data to the WRITE protocol observations for each teacher in order to note similarities or differences between teacher beliefs and actions in the classroom.

Findings

Given the limited research on writing instruction in early childhood classrooms (Hall & Grisham-Brown, 2011; Hindman & Wasik, 2008), the goal of this study was to understand what writing supports were used, the teacher/child interactions, and how these preschool teachers' beliefs about writing aligned with their classroom practice. The findings are organized by the overall frequency observed of the various components on the WRITE protocol. It is important to note that each of the five components of the protocol had a different number of aspects to observe. See Table 1 for this information as well as frequency counts for each area of the tool across the six teachers.

Environmental Print

Compared to the other components of the WRITE protocol, the most examples consistently seen among all of the teachers was in the area of Environmental Print, which was observed 78 times. Environmental print includes the text that children see, create, and interact within their surroundings (Neumann, Hood, Ford, & Neumann, 2012). During our observations, we specifically looked for displayed individual children's or group writing,

signed art, labels, alphabet, posters, charts, calendars, word walls, teacher-child created books, and teachers and/or children referencing environmental print for writing.

Adele described her belief about environmental print in her classroom as being an essential component because:

Most of our children speak other languages and posting labeled items around the classroom allows the children to explore letters. There should also be an alphabet, word wall at a level that a child can access and explore. Children begin to recognize their peers' names first and it's important to have this for students to explore.

In Adele's classroom we observed students writing their names on their work. We also noticed, she had the alphabet and a word wall displayed for students to reference. The word wall included students' names along with their picture.

Another teacher, Anastasia, also believed in the power of environmental print. She indicated that:

Being that the students are preschoolers and cannot read yet, recognizing letters and pictures in their environmental is very important. By having a variety of books with pictures, labels at each center in the room, and the alphabet and children's names posted allows them to practice recognizing these letters and "reading" what is around them.

Her classroom was set up to align with this belief. For example, we often saw students reading teacher-created books together in the reading center and students referencing the center signs.

Kelly utilized environmental print in her classroom by displaying student work low enough so the children could periodically change out what was showcased. She shared that at first, she would call attention to their names but soon students would begin to notice not only their names but also the names of their classmates.

These teachers' classrooms were excellent examples of intentionally filling learning environments with environmental print. Preschool students need these supports so that they are more motivated to eventually write on their own. As children observe, read, discuss, and copy the signs and symbols in their world, they become aware that literacy is part of everyone's daily activities. They come to realize that reading and writing fulfill various purposes and functions in their lives. Consciously capitalizing on children's familiarity with environmental print as an aid for early writing is one way to promote their progress on the road to becoming independent authors.

Writing Environment

The highest quality early literacy environments are filled with opportunities for children to engage with print (Casbergue, 2017). However, despite extensive literature that recommends and describes literacy rich environments, according to Clark and Kagler (2005), many early childhood programs still do not provide this type of environment for students. However, the data from the six teachers in this study clearly showed that each believed in the importance of the writing environment. Writing Environment was the *second* most observed component of the WRITE protocol, examples were seen 66 times. The components of this section included: a place for students to sign in, journal time, electronic writing tools, a variety of paper, a writing center, and writing materials in other areas of the classroom.

Anastasia stated, "I think a lot of [children] become very creative and empowered when they see themselves writing." She believed in a writing environment that promotes confidence in writing. The writing environment she created in her classroom aligned with her beliefs, because students were provided with different tools and ways to engage with writing including markers, chalk, and different types of paper. Additionally, Anastasia provided students with alternative modes to engage in writing including using play dough to model letters and an etch-a-sketch. By providing students with these different modes of interactive

writing and allowing them the choice of which modes they used, Anastasia promoted creativity and independence.

Amy shared, “Writing should take place in various places in the classroom, providing various purposes for the children in their play. There should be opportunities for the children to explore materials on their own, and have instruction on how to appropriately use the items.” During observations, it was noted that different writing materials were provided in various centers putting opportunities for independent writing in the children's hands.

Kelly pragmatically stated, “Students should understand the importance of writing and why they will need to know how to write in their future.” One example we saw repeatedly in Kelly’s classroom was how she encouraged students to use laminated name cards. Each child’s name was printed on a card and a photo of them was glued next to it. This action aligns with Kelly’s belief in the importance of writing, specifically that it is necessary to be able to read and write friends’ names.

In her interview, Adele shared, “Preschool children should be exposed to writing every day. Different types of writing tools should be in centers for students to freely explore. Teachers should also do shared writing activities to expose children to directional writing, capitalization, and punctuation marks.” The components of the writing environment, a place for students to sign in, journal time, a writing center, and writing materials, are about either providing a space or writing or allowing time for writing. The alignment between teachers’ beliefs about the importance of the writing environment and how they structured their classroom mostly aligned.

Teacher Modeling Writing

According to the WRITE protocol, Teacher Modeling included some of the following: teacher writing letters/words/symbols, teacher drawing attention to writing as she writes, teacher writing children’s words, and engages children with interactive writing. One of the

ways the teachers in this study were seen modeling writing was through interactive writing. Hall (2016) states that this is a powerful strategy to use in early childhood settings because it incorporates a variety of literacy skills and teachers can select appropriate content based on the needs and interests of their students. Teacher Modeling writing was the third most observed component of the WRITE protocol, seen 33 times.

Adele's beliefs and actions aligned specifically to teacher modeling writing. In her interview, she stated, "It is important that teachers model correct writing early to our preschoolers. They may not be able to write yet but modeling is so important in younger children. They take in what the teacher does." Like other teachers in her building, Adele's beliefs were seen in action during our observations. For instance, when she conducted the morning message with her students, she enacted her beliefs about the significance of shared writing and exposing students to directional writing, capitalization and punctuation.

When talking about teacher modeling writing, several teachers like Anastasia mentioned the program Handwriting Without Tears (Olsen, 2003) which is a developmentally and multisensory based handwriting curriculum created by an occupational therapist. Some of the teachers had access to the materials from this program, but only a few had attended the training. Anastasia shared, "... so we talk about lines and curves. We usually do three or four letters each week, so we practice, like grip and all that." During message time, Anastasia was often seen playing a song and video about a specific letter of the alphabet on the Promethean board. She would then write a message that contained many words starting with that letter, drawing the children's attention to the letters as she wrote them.

In her interview, Amy stated, "I think teacher modeling writing is the first step to children learning to write. Through doing this, the children can learn simple concepts like directionality, how to make spaces in between words, how to form letters, etc." Amy's implementation of modeling aligns closely with her beliefs about modeling writing for young

students. Amy was observed modeling during message time when she asked specifics about spacing between words, directionality, what we do when we get to the end of a line.

Additionally, Amy was observed verbally describing shapes/movements as she made each letter.

Lori, the special education teacher, discussed writing in her interview by stating, “It is one-on-one. Entirely one-on-one, and a lot of times you have a reinforcer. If you know the student likes M&Ms, you get M&Ms, and if they do it right, they get M&Ms.” During observations, Lori and her teaching assistants worked on specific skills with each student, such as drawing a circle or a straight line. Lori would set up an incline board with a large piece of paper on it. First, she would model the mark and then the student attempted the task. If the student was successful, then they would get a reinforcer such as food or time on an iPad.

Kelly was adamant when talking about the importance of teacher modeling. She said, “This needs to happen often! Go into great detail about how you are forming the letters and later on have children copy your model.” During message time, Kelly, like the other teachers, was seen modeling writing as she states in her quote, but what was not observed was how Kelly or other teachers were having children copy the model.

Lydia stressed the power of modeling but also how children should see teachers make and correct errors in their writing. She said, “I believe the children should see us write as much as possible and make mistakes and learn how to fix them.” During message time, Lydia was observed writing on the board, but we did not see her specifically make mistakes, draw the children’s attention to it, and then fix it.

Teacher modeling was mainly observed during message time. How much each teacher drew student’s attention to writing, varied, but all teachers planned and allowed time each day for this activity. This shows that they clearly saw this as time well spent.

Independent Child Writing

The second least observed section on the WRITE protocol was independent child writing, observed 20 times. Gerde et al. (2015) included child using writing in play or activity, child writes at a writing center, child writes letters, words, symbols in this section. Although we did not observe as many instances of independent child writing, the teachers clearly articulated their opinions on this topic.

Adele believed, “Students learn best through hands-on exploration.” She specifically highlighted the writing center in her classroom which, “allows children to explore on their level with appropriate guidance.” Anastasia also valued hands-on learning and this was most clearly seen in both Adele and Anastasia’s classrooms when children chose to write at the writing center. For example, the students in Anastasia’s class enjoyed the ‘roll n write’ game. This fostered independent writing by allowing students to be in control of their writing as they rolled a letter die, wrote the letter, and then engaged in conversation with their peers about words that begin with that letter.

Lori said, “Because of motor delays, letters are hard to form, so we have stamps. And that’s what we work on. Getting them to recognize their name and then stamping it out.” Although we did not see Lori using stamps during any of the observations, which occurred in the fall and winter, we did see her work with the children on letter identification with letter cards. Using the stamps might be something that occurred later in the year, after the children were able to recognize their names.

Amy shared, “Independent writing is good for children because it is a great time for them to practice what they are learning, build on what they know, and that can then be geared towards the child’s interest.” Similar to an example mentioned earlier in Kelly’s classroom, Amy also used laminated name cards and students were often seen getting the cards and

taking them to various centers so they could independently write other students' names on work they created for each other.

Despite these examples, we did not observe many examples of independent writing, and what we did see, mainly occurred at the writing center. Although the paper and writing utensils at the writing center were available for children to take to other centers to incorporate into their play, this was not something we saw teachers encourage or children choose to do.

Teacher Scaffolding Writing

An important part of the writing process for young learners is scaffolding. Teachers can scaffold students' writing in a variety of ways, but often the process includes directing, prompting, and reminding. Quinn et al. (2016) recommends that children in preschool classrooms need a range of support from low to high levels. This type of individualized and scaffold writing instruction is key to supporting writing development. This section of the WRITE protocol, which included teacher reminding a child to write their name on work, teacher writes a letter/word for a child to copy, and teacher creates letters to trace to prompt writing were observed the *least* frequently, seen 17 times.

Adele stated in her survey response that it is "important to teach to each child's individual level." Adele believed that using centers in the classroom allowed teachers to scaffold and meet children's individual needs. One example of this, seen during an observation, was how she created dotted letter shapes for students to trace at the writing center.

Amy believed that teacher scaffolding was, "paramount to [children's] success in writing,' and that teachers must 'start where the child is [in order] for them to succeed.'" On many occasions, Amy was observed scaffolding her students' writing by using hand-over-hand assistance. Each day the class had time set aside for message time which in Amy's classroom, always included a sentence with alliteration based on the letters they were

focusing on that week. For example, one message read, *I made a pepperoni and pepper pizza for the surprise party*, which contained many letter p's. Amy then invited students to the board to find the p's in the message. A child would come up, circle a p, and then turn around and say, "I found P!" to all of their peers. After all the letters were found, Amy invited a few students up to practice writing the letter p. One child had trouble making "the hump on top," so Amy placed her hand on top of the child's and helped her finish writing the letter. Afterwards, Amy allowed the child to try again on her own. There were also many instances when Amy verbally described a letter shape while encouraging students to write the letter in the air with their pointer fingers as she wrote on the board. For example, when describing W, she exclaimed, "slide down, slide up, slide down, slide up," as she wrote the letter 'W' on the board for students. These instances and others helped us conclude that her actions aligned with her belief about scaffolding children's writing.

Being that Lori is in charge of a special need's classroom, child writing looks very different when compared to other classrooms. However, Lori's practices mirrored her beliefs about scaffolding which was seen as she assisted her students in making marks by using hand-over-hand assistance when writing. When asked about her beliefs about scaffolding, Kelly referenced Handwriting Without Tears. Her experience with this program may influence her particular attention to the order children should be taught to form letters. She stated, "[We use] Handwriting Without Tears to get the basic straight and curved lines down." Unfortunately, there were no observations that connected directly to her stated beliefs about scaffolding children's writing. Teacher scaffolding was observed the least and when it was, it mainly occurred in the form of teachers encouraging students to write their names on their papers or as part of message time.

The findings we just shared highlight overviews of the observations, surveys, and interviews we conducted across the six teachers. Table 1 showcases the specific frequency count of each teacher across each of the five components of the observation tool.

Table 1

Frequency Counts Per Teacher

	Writing Environment 11 categories	Environmental Print 10 categories	Teacher Models Writing 6 categories	Teacher Scaffolds Writing 9 categories	Independent Child Writing 3 categories
Anastasia	18	18	10	6	8
Amy	10	16	8	1	5
Lori	6	4	0	3	0
Kelly	13	16	5	3	3
Adele	7	11	5	2	3
Lydia	12	13	5	2	1
Totals	66	78	33	17	20

It is essential to note that measuring one's beliefs is difficult to do. In addition, Gill and Hoffman (2009) note that particular behaviors do not directly imply particular beliefs. Furthermore, we recognize that we only observed the teachers over the course of a semester and during times we were not observing, they might have included practices in their classroom that more closely aligned with the beliefs they shared. Although these points are important to keep in mind, the findings from this study provide further evidence that preschool teachers' beliefs do not always align with the practices they implement in their

classrooms (Korth et al., 2017). Next, we explore some potential underlying tensions for this disconnect and offer some viable solutions.

Discussion

In this study, across the six classrooms, a variety of writing materials were provided and teachers engaged in modeling using these materials, but there was a clack of scaffolding and perhaps as a result, a lack of independent child writing. Interestingly, across the six teachers, one teacher did not stand out as having a closer alignment between her beliefs and practices than others. Furthermore, none of the teachers mentioned in the interviews or surveys any specific challenges, such as time or lack of knowledge, that interfered with them implementing their beliefs specific to writing instruction.

In this study, message time carried the weight of writing instruction and we wonder if there are ways for teachers to embed writing instruction in other parts of the day. We believe that embedding a strong component of writing into each of the learning centers is one solution. For example, at the grocery store center having a tablet of paper and pencil available for students to create a grocery list or a sales receipt and making sure teachers model these options when opening the center would add a component of writing for students to see the purpose of writing.

The amount of consistency between classrooms and overlap of classroom observations may be due to co-planning. We wonder then if the co-planning, although a time saver, is perhaps interfering with teachers being able to enact their individual beliefs about writing instruction. Besides some mention of Handwriting without Tears, the teachers shared in their interviews that they had not had any professional development specific to writing and it was not a focus in their teacher education programs. By not recognizing any of the challenges that prevented the teachers from embedding more writing instruction into their classrooms, perhaps may be attributed to a lack of knowledge of the possibilities.

Although our findings are not meant to be generalizable beyond the teachers we spent time with, awareness of their practices and beliefs can be informative to anyone who works with children and wants to understand what is and/or what is not occurring with writing in early childhood classrooms. This is especially important since teacher beliefs act as a filter through which they interpret new information (Borg, 2003).

Implications and Conclusions

Like Gerde et al. (2015), we think our observations of and conversations with the six teachers is the first step in further supporting writing in their preschool classrooms. Because of the detailed categories of the WRITE protocol, this tool could be used by teachers to self-reflect about their writing beliefs and then having colleagues or administrators note what is actually observed in practice would be a constructive way for teachers to improve their practice. It is clear that the teachers in this study, and many other preschool teachers (Korth et al., 2017), would benefit from additional professional development specific to writing instruction. This is necessary so that teachers can understand the opportunities they have and the importance they must place on guiding early writing instruction.

The WRITE protocol has been used in other studies such as Gerde et al. (2019) to document writing in early childhood classrooms. This was our first time using this tool and some of our observations of the six teachers did not fit neatly into the five categories of the WRITE protocol. Specifically, technology. The only place technology is mentioned is in the Writing Environment section where electronic writing tools can be noted. However, upon further analysis, there were additional areas within the protocol where technology could fit, such as in the Teacher Modeling writing section. For example, if a teacher were to use an interactive white board, like we observed in some classrooms. Or it could be notes in the Independent Child Writing section if a child used a writing application on an iPad. We do not believe technology should be a category of its own on the WRITE protocol because it should

enhance the learning that is already occurring, not be a sole focus. Future studies could expand the tool to incorporate technology into each section and examine teachers' beliefs about the role of technology and young children's writing.

The importance of a strong alignment between teacher beliefs and practices has been addressed in the literature for years, however although preschool teachers are aware of writing development they still struggle to implement appropriate instructional practices. We believe that through thoughtful teacher education practices and strategic professional development we can address teachers' beliefs and practices specific to supporting young writers so that we can shift the focus of early literacy instruction to focus beyond learning to read.

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Virtualizing Science to Maximize Self-Efficacy, Value, and Motivation for Tomorrow's Science Workforce

Li-Wei Peng and Cheun-Yeong Lee

Abstract

The research partnership among university faculty, information technology graduate students, and science content experts from school districts developed the Web-based two-dimensional and three-dimensional virtual reality science games. The games were implemented to engage middle school students in learning, retaining, and applying newly acquired scientific knowledge in novel settings. The quasi-experiential study investigated the impact of gender, grade levels, and educational experiences (i.e., with games vs. without games) on sixth and eighth graders' self-efficacy in learning science, value of science, motivation in science, and perceptions of virtual reality science games in science classes. A total of 255 participants' responses from four rural Appalachian middle school science classrooms in southeastern Ohio were analyzed through a three-way ANCOVA factorial pre-test and post-test data analysis with experimental and comparison groups. The results indicated that the diversity of educational experiences was a significant factor that impacted sixth and eighth graders' perceptions of science. The findings of the two short-answer questions identified the reasons why the participants liked or disliked science, as well as why the participants would or would not choose a career in science. The conclusions discussed the practices that strengthen students' attitude toward science and careers in fields of science.

Keywords: virtual reality science games, science education

Li-Wei Peng Ph.D. is Associate Professor of Educational Technology and Coordinator of the Online Teaching and Learning Certificate Program at Governors State University. She can be reached at lpeng@govst.edu

Cheun-Yeong Lee Ph.D. is an adjunct professor in the Online Teaching and Learning Certificate Program at Governors State University. He can be reached at cle6@govst.edu

The university faculty and information technology graduate students at a Midwestern university and the science content experts from school districts developed the Web-based two-dimensional and three-dimensional virtual reality science games with Flash, the STEAMiE Educational Engine, and Second Life as middle school science curriculum supplements. The topics and contents of the games are based on the *National Science Education Standards* (http://www.nap.edu/catalog.php?record_id=4962) and the *Ohio Science Academic Content Standards* (<http://education.ohio.gov/GD/Templates/Pages/ODE/ODEDetail.aspx?page=3&TopicRelationID=1705&ContentID=834&Content=51519>).

Middle school science teachers in southeastern Appalachian integrated the games into their classroom activities to engage their students in learning, retaining, and applying hard-to-teach and difficult-to-learn science concepts in novel settings. Mubireek (2003) discovered that the integration of virtual reality games into the educational environment allows students to move at their own pace and the educational process becomes more personalized for the students.

The quasi-experiential study investigated the impact of gender (male or female), grade levels (sixth grade or eighth grade), and educational experiences (engaged with virtual reality science games or not engaged with virtual reality science games) on sixth and eighth graders' self-efficacy in learning science, value of science, motivation in science, and perceptions of virtual reality science games in science classes. Studies (Jones, Howe, & Rua, 2000; Weinburgh, 2000; Baker & Leary, 1995; Hykle, 1993; Pogge, 1986; Simpson & Oliver, 1985) completed in the past two decades have demonstrated that people have different self-efficacy, values, motivations, and perceptions of science based on their gender, grade levels, and educational experiences.

The following were the three quantitative research questions for the three primary purposes of this study:

1. Are there significant differences in perceptions of science between the students engaged with virtual reality science games and the students not engaged with virtual reality science games?
2. Are there significant differences in perceptions of science between male and female students?
3. Are there significant differences in perceptions of science between sixth and eighth graders?

Literature Review

Virtual Reality Games in Science Classrooms

The growing interest in the use of games and simulations for educational purposes, particularly with regard to teaching curriculum subjects, is evidenced in the literature, as well as in recent research projects and initiatives (Freitas & Oliver, 2006).

Flash Games in Science Classrooms

Macromedia's Flash with interactive features is commonly used for developing educational games. Flash allows game developers to create two-dimensional virtual reality games with sound, videos, pictures, and animation. Students can interact with Flash games to learn science content through the process of playing games. Data collected by the STEAM project (Ohio University Vital Lab, 2008) indicated that students working in Flash two-dimensional games have improved the mean scores on content achievement tests. Flash games, in general, have a positive effect on middle school students' learning outcomes.

The STEAMiE Educational Engine Games in Science Classrooms

The STEAMiE Educational Engine (SEE) is software with multiple development tools and collaborative environment for game developers to easily and rapidly create three-dimensional immersive games containing both educational and entertaining content with little effort and training. "A motivated middle-school student, using SEE, could create a virtual

world within several minutes of opening the New Module template” (Nykl et al., 2008, p. 24). Virtual reality science games developed using SEE are designed for supporting science learning in an interactive way.

Second Life Games in Science Classrooms

Linden Lab’s Second Life (<http://www.secondlife.com>) is an online collaborative world supporting tens of thousands of online users simultaneously (Nykl et al., 2008). The growing interest in using educational content in Second Life within the classroom setting is evidenced in recent research projects and initiatives. Second Life is a virtual environment in which owners can build communities for their own purposes. Teen Life is a space in Second Life available only for individuals between the ages of 13 to 17.

SciLands is an example of using Second Life in science education. SciLands is a specialized island in Second Life with an extended network for organizations interested in shared resources, innovation, knowledge transfer, research and science education using Second Life (Les, 2008). Moreover, the local New York City ABC affiliate, WABC-TV/DT (2008), aired a piece describing the Second Life Science Class as a pilot program founded by the not-for-profit Global Kids' Online Leadership Program. This program let Second Life become part of a science class at Brooklyn High School in 2007, and this experience demonstrated that Second Life was an innovative program that allows students to experience science lessons that are out of this world, but inside any computer (WABC-TV/DT, 2008). Applying Second Life in science curriculum is a byproduct of the current rapidly expanding technological revolution of enormous proportion. Institutions researching and developing instructional materials in Second Life for science classrooms have popularized and practiced their ideas in schools.

Why Virtual Reality Science Games Work

The growing discussion for the reasons why virtual reality science games engage

students and support learning is evidenced in the literature and recent research projects. Dr. Robert Ahlers and Roseemary Garris (cited by Prensky, 2001) of the Navy's NAWCTSD Submarine Lab concluded after a three-year long study why games work. Based on their theory, virtual reality game-based learning works for the following reasons:

1. Virtual reality games provide opportunities for success from the games' goals, rules, and control of one's destiny which lead to a sense of purpose;
2. Virtual reality games appeal to curiosity from surprise, complexity, mystery, and humor which leads to fascination;
3. Virtual reality games allow social reinforcement from online conversations, game chat rooms, scoreboards, and game interactions which leads to a sense of competence.

Dr. Robert Ahlers and Roseemary Garris (cited by Prensky, 2001) found that games create a self-perpetuating learning cycle of initiate–persist–succeed, as players initiate game play, adopt a role, control game play, practice skills, solve problems, persist to the end and strive to win which is considered learning, a process which then leads to re-initiation of the cycle (Pellegrino & Scott, 2004).

Prensky (2001) addressed his findings and suggested it is useful to think of virtual reality game-based learning along the two principal dimensions of why it works: engagement and learning (Figure 1). Prensky (2001) deemed that virtual reality game-based learning involves high engagement and high learning while computer-based training is basically low engagement and low learning, and pure games alone are high engagement and low learning. Prensky (2001) claims that virtual reality game-based learning blends engagement and learning with balanced emphasis on both elements. Each game in virtual reality game-based learning has a different amount of both learning and engagement that teach what is required; learners can choose games containing suitable engagement and learning based on their mood

and preferences.

Figure 1

Virtual Reality Game-Based Learning

Engagement	HIGH	Pure Games	Virtual Reality Game-Based Learning
	LOW	Computer-Based Training	(Null – No Existence)
		LOW	HIGH
		Learning	

Note. Virtual reality game-based learning comes only when engagement and learning are both high. From “Digital Game-Based Learning,” by M. Prensky, 2001, *Digital Game-Based Learning*, p. 149. Copyright 2001 by Marc Prensky. Adapted with permission of the author.

Virtual reality game-based learning also fits well with the concept of learning by doing. Many types of virtual reality science games, such as simulation games and role-play games, are examples of delivery tools for goal-based or scenario-based learning (Schank, 1996). Simulation-based virtual reality science games, “make possible ‘learning by doing’ because it focuses on the learner’s performance outcomes in a context that mirrors the real work environment, demands more intuitive responses (judgment), is usually constrained by time, and takes into account the complexity of possible interactions across key variables” (Kindley, 2002, p. 3). The learning goals of virtual reality science games which provide artificial and heuristic opportunities for learners to increase hands-on learning focus on abstract and intuitive knowledge and skill acquisition. Virtual reality science games commonly employ instructional strategies by developing a character, asking appropriate questions, giving feedback and providing hypothetical examples. This strategy leads to a better recollection of details as well as both motivates learners and allows them to learn while doing which involves emotional and physical interaction. It also supports why virtual reality

science games work.

Gender, Grade Levels, and Educational Experiences

According to Jones et al. (2000), beginning as early as elementary school, males and females have significantly different attitudes toward science in terms of earth and space sciences, life sciences, physical sciences, sciences and technologies, and scientific inquiries taught in science classes. The different perceptions of science between males and females continue to expand from middle school through high school. Even though females are more interested in school and school learning in general, males consistently hold more complimentary attitudes toward science classes than females (Keeves & Kotte, 1992). Schibeci (1984) reported that gender is a variable which has generally been shown to have a consistent influence on attitude toward science. In 1986, M. Sadker and D. Sadker indicated that gender differences are more distinct in middle school, while Weinburgh (1994) added that gender differences continue into high school and that grade level is a significant predictor of students' attitudes toward science. Weinburgh's (2000) study indicated that the positive attitudes toward science decline with each grade level.

Weinburgh (2000) further indicated that having diverse school experiences in science between males and females is one of the factors causing males and females to have unlike attitudes toward science over childhood, adolescence, and adulthood. Studies (Jones et al. 2000; Baker & Leary, 1995) pointed out that there is growing evidence that science experiences affect science career selection.

Understanding the variables and issues that most influence people in developing their attitudes toward science and how those attitudes affect their self-efficacy, values, motivations, and perceptions of science is necessary for planning appropriate instructional intervention in middle schools which will impact people in developing more positive perceptions of science.

Theoretical Framework

This study has concentrated on using the Theory of Planned Behavior model to examine sixth and eighth graders' belief structures of science with the presence of the virtual reality science games in science classrooms. The study was designed to identify virtual reality science games as a factor influencing sixth and eighth graders' intentions to prepare themselves academically for scientific occupations. Therefore, a research model capable of identifying the intentions and beliefs linked to implementation behavior was needed. Because Ajzen's (1985) Theory of Planned Behavior provides a means to identify and examine the precursors to student learning behavior (intentions and beliefs), it was selected as the framework needed to accomplish the defined research goals.

Ajzen's Theory of Planned Behavior (1985) is a theoretical research instrument for understanding and identifying science education belief factors influencing both intention and behavior. Specific to science education research, the theory has been used to understand and predict motivation to achieve in science (Allen & Crawley, 1993), secondary science students' intentions to enroll in physics (Crawley & Black, 1992), junior high and secondary students' attitude toward participating in a district science fair competition (Czerniak & Lumpe, 1996), behavioral intentions of teachers enrolled in the Institute of Physical Science (Crawley, 1989), and teacher beliefs and intentions regarding the implementation of science education reform strands (Haney et al., 1996). Very few studies have focused on examining middle school students' belief structures using the Theory of Planned Behavior model; moreover, studies specifically examining middle school students' beliefs regarding science with virtual reality science games as a variable are equally rare.

From the Theory of Planned Behavior's perspective, in order to predict and understand the virtual reality science games' impact on sixth and eighth graders' perceptions of science, the first step is to examine students' motivation and attitudes toward using the

virtual reality science games as a supplement in learning science (attitude toward behavior). In general, young teens and older teens (girls and boys alike) like to play virtual reality games frequently (Lenhart et al., 2008). Sixth and eighth graders have a high motivation to engage in playing the virtual reality science games from class even in their own time after school (2007 VITAL STEAM Magazine, 2007). The research (2007 VITAL STEAM Magazine, 2007) reported that virtual reality science games attract students to approach studying science in a fun and interesting way. Virtual reality science games promote the science subject's appeal for most students. Consequently, students report a positive evaluation of engaging in studying science which is termed as attitude toward behavior. The Theory of Planned Behavior assumes that with a positive attitude toward behavior, students are likely to have high intentions to perform the behavior. The theory views intention as an immediate determinant of the behavior.

The second step to predict and understand virtual reality science games' impact on sixth and eighth graders' perceptions of science is to investigate beliefs about who would support or object to engaging in science-related studies and careers (subjective norm). According to Baker and Leavy (1995), female students' perceptions of interpersonal relationships impact their science career selections, particularly in second, fifth, eighth, and eleventh grades. The study (Baker & Leavy, 1995) reported that eighth grade female students like science in general, but they think that their friends would not be supportive of a female's career choice in science. The eleventh grade female students in the same study reported reversely. Females who accept science as a career option indicated that they have strong affective influences from their parents, teachers, or other significant individuals. Several middle school science teachers participating in the STEAM project (2007 VITAL STEAM Magazine, 2007) expressed that they were inspired by their parents or science teachers to become science teacher themselves. One of the participating teachers cited her mother and

her fourth grade teacher as major influences in encouraging her to become a science teacher. Another participating teacher was inspired by her third grade teacher to become a teacher herself. The teacher stated, “Mrs. Wigton really helped me as a student and I wanted to do the same for others” (2007 VITAL STEAM Magazine, 2007, p. 8). Therefore, subjective norm influences an individual’s perception of the value of science-related studies and careers.

The third step is to evaluate students’ perceptions of abilities and controls over the resources in science-related studies and careers (perceived behavioral control). Virtual reality science games visualize difficult and abstract science concepts with virtual animation which help students have a better understanding and improve their learning outcomes. Virtual reality science games allow students to interact with information at their own skill level and pace.

In the progression of the virtual reality science games integrated with the science curriculum, students are acting as an active partner in their learning, and not simply a consumer of knowledge (Smearcheck, Franklin, Evans, & Peng, 2008). Students can build up critical thinking skills and have the ability to access information they need to explore and investigate in their education. Students learn better in science as a result of having higher confidence in their abilities and control over the resources to approach advanced science studies or careers.

In terms of further understanding the behavior in the selection of science-related studies and careers, it is necessary to identify the two basic determinants of a person’s intention: intrapersonal and interpersonal factors. An individual’s positive or negative evaluation of performing a behavior is considered to be the individual’s intention of performing the behavior (Krynowsky, 1985). This study sought to examine whether the virtual reality science games have impact on sixth and eighth graders’ evaluation of pursuing or not pursuing science-related studies and careers. If the evaluation of the behavior is

positive when the virtual reality science games are presented, sixth and eighth graders' intention to choose science-related studies and careers is stronger.

The strength of attitudinal and normative factors may alter the weighed beliefs and people's opinions involved. For example, if a person has a negative attitude toward having a career in science (attitude toward behavior), he/she may still intend to get a job in science because of the person's perception that his/her loved or admired ones view the behavior positively (subjective norm). In addition, the Theory of Planned Behavior claims that a person's perceived behavioral control is the key determinant in performing actual behavior. An individual's regard of internal ability and external control for performing a behavior concludes the individual's intention of performing the behavior. Career choice and development is but one example of the power of perceived behavioral control to affect the course of life paths through choice-related processes. The higher the level of people's perceived behavioral control over a career, the greater their interest will be in it. Because of their increased interest, they will prepare themselves better academically for the occupational pursuit they choose, and their success in their pursuit will be greater (Bandura, 1994). This study sought to explore whether the virtual reality science games have an influence on sixth and eighth graders' perceptions of their internal ability and external control over their performance in science. Attitude toward behavior, subjective norm, and perceived behavioral control all work to influence people's intentions and actual behavior. To the extent that a student has a positive attitude toward devoting himself/herself to science studies and careers, that a student perceives people's opinions of having a career in science in a positive light, and that a student has the required ability, opportunities, and resources, he/she should most likely will dedicate his/her life to science.

Methods

The study adopted a 2 x 2 x 2 ANCOVA factorial pre-test and post-test data analysis

with experimental and comparison groups to research the virtual reality science games' impact on capturing the interest of both male and female students in sixth and eighth grades and increasing their self-efficacy, values, motivations, and perceptions of science. The three independent variables were gender (male or female), grade levels (sixth grade or eighth grade), and educational experiences (the experimental group engaged with virtual reality science games or the comparison group not engaged with virtual reality science games). The dependent variable was sixth and eighth graders' post-test perceptions of science. The pre-survey mean scores were the covariance. Adjusted mean scores of the post-survey were applied in analyzing the data. The pre-survey mean scores of the experimental and comparison groups were moved to the same number statistically in order to adjust the mean scores of the post-survey on the dependent variable. Therefore, there was a fair starting point for the pre-survey mean scores in the experimental and comparison groups statistically. The study had assumptions that the correlation value of the pre-survey and post-survey mean scores in the two groups was close to .70 and the regression lines of the pre-survey and post-survey mean scores in the two groups were parallel.

Sixty students (thirty sixth graders and thirty eighth graders) at two middle schools, respectively, in southeastern Ohio participated in the pilot study for assessing the magnitude of the scales in the science perceptions survey, as well as "specific matters such as developing questionnaire items, estimating internal consistency reliability, estimating survey response rates, and estimating effect sizes" (Johanson & Brooks, 2008, p. 1). In Johanson and Brooks' research (2008), they suggested that using thirty as the number of participants for each instrument in a pilot study is a reasonable recommendation because it provides the researcher maximum information at minimum cost.

The survey adhered to the pencil and paper format. The demographic information section which appeared at the beginning of the survey included six items: (1) code number,

(2) grade levels, (3) age, (4) gender, (5) years of using virtual reality science games in science classes, and (6) name of science teacher. At the end, the survey concluded with two short-answer questions, inviting thoughts on the science. The main section of the survey consisted of twenty-four items with a balance of positive and negative statements and an overall item – “Overall, I like the science,” at the end of the scale, on a Likert five-point scale, ranging from strongly agree to strongly disagree. The twenty-five items of the survey were constructed in the domain of perceptions of science to address factors reported to be critical indicators in Ajzen’s (1985) Theory of Planned Behavior model that students’ intention and behavior might perform. The items were constructed into four subscale categories to assess self-efficacy in learning science, the value of science, motivation in science, and perceptions of virtual reality science game in science classes.

A total of 255 students participated in the study. Seventy-four (thirty-five males/thirty-nine females) sixth graders in School 1 and sixty-one (thirty-one males/thirty females) eighth graders in School 2 who had played the virtual reality science games in their science classes for three months were the subjects in the experimental group. Sixty-one (thirty-one males/thirty females) sixth graders in School 3 and fifty-nine (thirty males/twenty-nine females) eighth graders in School 4 who had not played the virtual reality science games in their science classes were the subjects in the comparison group. These subjects were selected for participation in the study on the basis of comparable school systems and teacher willingness to participate.

In order to get a reliable predication equation in this study, SPSS (Statistical Package for the Social Sciences) was the software utilized to determine the sample size needed for the 2 x 2 x 2 ANCOVA factorial pre-test and post-test data analysis with experimental and comparison groups. As a result, for the two-tailed test with an alpha level of p set to .05, a medium effect size ($r = .60$), an f value equaled to .25, and a power of .80, the total number

of the sample size (N) was expected to be at least 136. The study endeavored to keep the number of participants as equal as possible in terms of gender, grade levels, and educational experiences.

There were three sections in the research procedures: (a) pre-survey, (b) treatment, and (c) post-survey. The study conducted participant observation to ensure the research setting and to supervise the extraneous variables during the research. The participant observation notes contained the class information notes (e.g., teacher, date, start time, end time, student numbers in male and female), teacher observation notes (e.g., instructional strategies, textbook, course content, class activities, assessment methods), student engagement notes (e.g., conversations, questions), and the virtual reality science game usage notes (e.g., topics, format, usage time).

Findings

Based on the purpose of the study and the findings of the subscales' correlations and factor analysis, the perceptions of science discussed in the quantitative research questions contained the following measurements:

Main Analysis

1. Overall perceptions of science (including all the subscales),
2. Attitudes toward science (including self-efficacy in learning science, value of science, and motivation in science),
3. Perceptions of virtual reality science games in science classes.

Additional Analysis

1. Self-efficacy in learning science,
2. Value of science,
3. Motivation in science.

Findings of Research Question 1

1. Are there significant differences in perceptions of science between the students engaged with virtual reality science games and the students not engaged with virtual reality science games?

The results of the 2 x 2 x 2 ANCOVA data analysis indicated that the experimental group and comparison group significantly differed in the main analysis – attitudes toward science measurement ($p = .016$). The additional analysis presented that the experimental group and comparison group were significantly different in the measurements of value of science ($p = .001$) and motivation in science ($p = .024$). It represented that there were significant differences in the attitudes toward science, as well as value of science and motivation in science between the students engaged with virtual reality science games and the students not engaged with virtual reality science games. Table 1 reported the mean square, partial eta square, and the p -values of adjusted post-survey mean scores in each measurement using educational experiences as the variable.

Table 1

Each Measurement's Mean Square, Partial Eta Square, and P-Values of Adjusted Post-Survey Mean Scores using Educational Experiences as the Variable

Main Analysis Measurements	Mean Square	Partial Eta Square	Sig.
Overall perceptions of science	.215	.006	.215
Attitudes toward science	.926	.023	.016
Perceptions of virtual reality science games in sciences classes	.821	.008	.166
Additional Analysis Measurements	Mean Square	Partial Eta Square	Sig.
Self-efficacy in learning science	.282	.004	.300
Value of science	3.307	.044	.001
Motivation in science	1.209	.021	.024

Findings of Research Question 2

2. Are there significant differences in perceptions of science between male and female students?

According to the results in the data analysis, the p -values of all the adjusted post-survey mean scores in all the measurements considered by male and female exceeded the critical value $\alpha = .05$. These results indicated that none of the adjusted mean scores of the post-survey with any measurement showed any significant differences between the gender. Specifically, there was no significant difference in the perceptions of science between male and female students. Table 2 indicated the mean square, partial eta square, and the p -values of adjusted post-survey mean scores in each measurement with gender as the variable.

Table 2

Each Measurement's Mean Square, Partial Eta Square, and P-Values of Adjusted Post-Survey Mean Scores using Gender as the Variable

Main Analysis Measurements	Mean Square	Partial Eta Square	Sig.
Overall perceptions of science	.165	.005	.278
Attitudes toward science	.130	.023	.366
Perceptions of virtual reality science games in sciences classes	.322	.003	.385
Additional Analysis Measurements	Mean Square	Partial Eta Square	Sig.
Self-efficacy in learning science	.737	.011	.094
Value of science	.069	.001	.627
Motivation in science	.291	.005	.266

Findings of Research Question 3

3. Are there significant differences in perceptions of science between sixth and eighth graders?

The adjusted post-survey mean scores' p -values in all the measurements were greater than .05. when looking at the different grade levels. These values suggested that grade levels in this study were not the variable affecting students' perceptions of science. There is no

significant difference in the perceptions of science between sixth and eighth grade students.

Table 3 shows the mean square, partial eta square, and the *p*-values of adjusted post-survey's mean scores in each measurement using grade levels as the variable.

Table 3

Each Measurement's Mean Square, Partial Eta Square, and P-Values of Adjusted Post-Survey Mean Scores using Grade Levels as the Variable

Main Analysis Measurements	Mean Square	Partial Eta Square	Sig.
Overall perceptions of science	.056	.002	.527
Attitudes toward science	.010	.000	.800
Perceptions of virtual reality science games in sciences classes	1.042	.010	.119
Additional Analysis Measurements	Mean Square	Partial Eta Square	Sig.
Self-efficacy in learning science	.284	.004	.298
Value of science	.912	.013	.078
Motivation in science	.526	.009	.135

Discussion

Educational Experiences' Impact on Sixth and Eighth Graders' Perceptions of Science

The results found in the 2 x 2 x 2 ANCOVA data analysis indicated that the diversity of educational experiences was a significant factor that impacted sixth and eighth graders' perceptions of science in terms of attitudes toward science, value of science, and motivation in science. The comparison group had higher adjusted post-survey mean scores in these measurements than the experimental group did. Table 4 presented the adjusted post-survey mean scores of the experimental and comparison groups in the measurements of attitudes toward science, value of science, and motivation in science.

Table 4

Experimental and Comparison Groups' Adjusted Post-Survey Mean Scores in the Three Measurements

Three Measurements	Experimental Group (N = 135) Mean	Comparison Group (N = 120) Mean	Mean Difference (Experimental-Comparison)
Attitudes toward science	3.4262	3.5498	-0.1236
Value of science	3.539	3.77	-0.231
Motivation in science	3.376	3.516	-0.14

Educational virtual reality games' rich learning environment can be highly entertaining, but literature (de Freitas, 2007; Rutter & Bryce, 2006; Van Eck, 2006; Conati & Zhao, 2004) has shown that there is a need for more empirical evidence supporting that this kind of learning environment always triggers learning or enhances students' attitudes toward science, value of science, and motivation in science because most of the research results presented are based on theoretical assumptions. For instance, action-based games may bring on behavior based on repeated practice, trial and error, but do not allow players to reflect on outcomes, not to mention enhancing learning or attitudes toward the target subjects. In addition, "the use of technology alone does not motivate students who have lived in the midst of technology all their lives" (Kiili, 2005, p. 14). The integration of educational theories and game design, teachers' pedagogical interactions, other instructional activities, and each student's differences in goals, personalities, knowledge, and meta-cognitive skills (e.g., self-explanation, self-monitoring) are essential for students to actively build the connections between educational virtual reality games and underlying domain knowledge to enhance their learning, value, motivation, and attitudes (Kiili, 2005; Conati & Zhao, 2004). "If we continue to preach only that games can be effective, we run the risk of creating the impression that *all* games are good for *all* learners and for *all* learning outcomes, which is categorically *not* the case" (Van Eck, 2006, p. 2).

The Reasons Students Like and Dislike Science

The participants were encouraged to fill out the two short-answer questions at the end of the pre-survey and post-survey, respectively. The first short-answer questions aimed to understand the participants' perceptions of the science classes they had taken prior to the research period and within the research period. The second short-answer questions sought to explore the participants' choices of scientific careers in the future and the reasons for their choices at the beginning of the research period and at the end of the research period. The two short-answer questions are as follows:

1. Please answer one of the following questions:

If you like science – why do you like science?

If you do NOT like science – why do you NOT like science?

2. If you were going to have a career in science, what career would you like to have? Why?

Although there were gender, grade level, and educational experience distinctions within the participants in this study, there were no significant influences on the student responses to the two short-answer questions. According to the discoveries of the two short-answer questions, the reasons why the male and female sixth grade and eighth grade participants in both experimental and comparison groups liked science were:

1. Science involved hands-on activities;
2. Science contained favorite topics;
3. Science was interesting and fun;
4. Science was easy to understand and to get good grades;
5. Science related to daily life;
6. Science would help with a future job;
7. The participants liked science by nature;

8. The participants had a nice teacher.

These findings are supported by the literature of the past decades. Shaffer (2006) stated that “the typical caricature of progressive education is that progressives believe children should be free to learn by exploring their own interests” (p. 124). In order to stir learners’ interests in science and let learners be into science no matter what obstacle they encounter, learners have to be doing something relevant to their lives and something they care about (Shaffer). In Jenkins and Nelson’s study (2005), they found evidence that students who reported they liked school science regarded it as interesting, as well as relevant and important in everyday life. These findings are consistent with the Institute of Electrical Engineers’ (The Research Business, 1994) and the Assessment of Performance Unit’s (1988) conclusions cited by Osborne et al. (2003). Osborne et al. (2003) supported that the reasons why students like science are divided into two factors: (1) innate and intrinsic interest, and (2) situational and extrinsic interest. The latter is stimulated by the factor as Sharp, Hutchison, Davis, and Keys (1996), Woolnough (1994), Myers and Fouts (1992), Piburn (1993), and Brown (1976) identified that conducting good classroom variables, such as hands-on activities (e.g., experiments, gaming), separate subjects (e.g., physics, biology), and supportive teacher-pupil interactions (e.g., teachers’ patterns of communication with pupils, transmissions of teachers’ expectations to pupils, the variety of teaching strategies applied in class, particular topics covered in lessons with a high level of involvement). Ebenezer and Zoller’s (1993) study confirmed that the significance of the science teacher (e.g., quality of science teaching, content knowledge, enthusiasm) is the most important variable affecting students’ attitudes toward science. With positive science learning experiences of activities and teacher-related comments, students may have better comprehension and achievement in science and consider science as their favorite subject. Additionally, the Institute of Electrical Engineers (The

Research Business, 1994) indicated that students who like science often believe such notions as science offers better employment prospects and is useful for jobs. There is no significant distinction between genders.

On the other hand, the male and female sixth-grade and eighth-grade participants in both experimental and comparison groups indicated that they disliked science because:

1. Science was hard;
2. The participants lacked interest in science;
3. The participants had negative perceptions of science from their science teachers;
4. Science conflicted with participants' religious beliefs.

These findings are similar with the notions of Osborne et al. (2003), Havard (1996), and Ebenezer and Zoller (1993) that students find science abstruse (physical sciences particularly) and fail to perceive its value and relevance to their everyday lives and careers in the future, arguing that they will not need to know further science and do not sustain interest in it. Nilsson (2008) stated that "many students show little interest in their studies of science and often express an active dislike of it" (p. 1). Additionally, the student response in this study can also be found in Kekelis, Ancheta, and Countryman's (2005), Sundberg, Dini, and Li's (1994), and Ebenezer and Zoller's (1993) research stating there is a chasm between science teachers and students in terms of science value and usefulness, invitation and encouragement to science courses, enrichment opportunities, and confidence to learn and do well in scientific studies or works due to the teachers' pedagogy and students' personalities and learning styles; therefore, students' appreciation of science decreases. In Miller, Scott, and Okamoto's (2006) study, it was found that students with religious beliefs who see Genesis, for example, as a true and accurate account of the Creation may supersede scientific findings or interpretations, such as evolution in genetic literacy. As a result, these students may perceive science instruction as

ineffective and a waste of time, and then indicate their antipathy against science.

Some participants reported that they sometimes liked and sometimes disliked science due to the science content and activities, or they were neutral about science. This discovery is similar with Osborne and Collins' (2000) finding that students' attitudes toward school science show discrepancies with the specific science content. Hendley, S. Stables, and A. Stables (1996) concluded that, science is a love-hate subject that reduces strong feeling in students.

The Reasons Students Choose or Do Not Choose Scientific Careers

The reasons generalized from the participants why the male and female sixth-grade and eighth-grade participants in both experimental and comparison groups would choose a career in science were:

1. Interest,
2. Salary,
3. Subjective norm.

A similar finding was revealed in earlier research of Whitehead (1996) that in terms of career aspirations, there is no significant difference between males and females. Additionally, having interests in STEM-related careers is one of the significant reasons students choose a career in scientific fields. Generally speaking, students have the impression that people who work in scientific careers (such as engineers, astronauts, and doctors) have good status, recognition, and income which motivate students to prepare themselves for entering scientific careers (Whitehead, 1996). Science teachers' teaching styles, curriculum content, and encouragement from teachers, parents, and friends will lead students to positively perceive their capabilities of doing jobs in scientific fields.

In contrast, the inductive reasons why the male and female sixth grade and eighth-grade participants in both experimental and comparison groups would not consider

having a career in science were:

1. Not being interested in scientific careers,
2. Having non-scientific career choices in mind,
3. Lacking self-efficacy and perceived behavioral control of science.

Some participants stated that they were not sure which scientific career they were going to have, whether they would want to have a career in science or not, or which careers involved science. Similarly, Osborne et al. (2003) concluded from literature in the 1990s and 2000s (Fielding, 1998; Munro & Elsom, 2000; Jovanovic & King, 1998) that one of the reasons students choose not to pursue a career in scientific fields is that none appeals to them.

Furthermore, due to the disconnection between the decontextualized teachers and high-tech scientific society, students lack opportunities to extend their knowledge of science-related fields and careers outside of school; therefore, students may have limited scientific career options in mind. Students who regard that school science is recondite and full of challenges may reflect their declining desires to engage in scientific careers and perceive themselves to have better capabilities of doing a job in other areas.

Conclusion

The study provided information on the sixth and eighth graders' perceptions of science, as well as their intentions and potential behaviors in having a career in science associated with students' gender (male or female), grade levels (sixth grade or eighth grade), and educational experiences (the experimental group engaged with virtual reality science games or the comparison group not engaged with virtual reality science games). The study findings suggested that students' educational experiences were the significant factors impacting sixth and eighth graders' perceptions of science in terms of overall perceptions of science, attitudes toward science, self-efficacy in learning science, value of science, and motivation in science. Kekelis et al. (2005) signified that "in middle school, students choose

courses and extracurricular activities that influence their academic and career paths” (p. 17). There was no general support to the view that grade levels significantly impacted students’ perceptions of science, although the adjusted post-survey mean score difference in each measurement was to be noted.

In terms of middle school students’ perceptions of science, the findings of the two short-answer questions on the science perceptions survey concluded that students who found that (1) science involved hands-on activities; (2) science contained favorite topics; (3) science was interesting and fun; (4) science was easy to understand and to get good grades; (5) science related to daily life; (6) science would help with a future job; (7) the participants liked science by nature; and (8) the participants had a nice teacher, showed favor toward science. In contrast, students who had impressions that (1) science was hard; (2) science was boring; (3) science teachers’ pedagogy was the cause of negative perceptions of science; and (4) science was in conflict with their religion, indicated their disfavor toward science. Furthermore, the reasons students would like to have a career in science were: (1) interest, (2) salary, and (3) subjective norm. On the other hand, the reasons students would not like to have a career in science were: (1) not being interested in scientific careers, (2) having non-scientific career choices in mind, and (3) lacking self-efficacy and perceived behavioral control of science. There is no significant distinction among gender, grade levels, and educational experiences.

Ajzen’s (1985) Theory of Planned Behavior argued that if a student has a positive attitude toward the behavior (i.e., value of science, motivation in science), perceived behavioral control (i.e., self-efficacy in learning science), and subjective norm (science teachers) in science, the student will intend to become involved in science. Consequently, the student will most likely devote himself/herself to science. The Theory of Planned Behavior has been successfully applied to some perceptions and behaviors found in this study; for

instance, perceptions of having a career in science, confidence in capability of proceeding further study in science, and social support from families, peers, and teachers are strong determinants of student choice to pursue science voluntarily. Simpson, Koballa, Oliver, and Crawley (1994) expressed:

The science education literature contains hundreds if not thousands of reports of interventions designed to change attitudes. Development of programs to influence the likelihood of certain science-related attitudes is important because it is assumed that changes in attitude will result in changes in behavior. (p. 223)

Zeldin, Britner, and Pajares (2008) stated that “the potential of self-efficacy and its antecedents to influence how people select or eliminate future activities has been used as a heuristic model in understanding career decisions” (p. 1037).

Ajzen’s (1985) Theory of Planned Behavior helps determine salient beliefs (e.g., computer and science gender bias) that can be reinforced or downplayed to affect relevant behavioral decisions by students. Based on the finding in this study: the experimental group had less value of science, motivation in science, and attitudes toward science (i.e., the combinations of self-efficacy in learning science, value of science, and motivation in science) than the comparison group, it is essential to further investigate the interventions – integration of educational theories and game design, teachers’ pedagogical interactions, other instructional activities, each student’s differences in goals, personalities, knowledge, and meta-cognitive skills (e.g., self-explanation, self-monitoring), and individualized support to enhance virtual reality science games’ effectiveness on students’ perceptions of science. In addition, it is critical to control the interventions (e.g., computer and science gender bias) and strengthen the connections (e.g., science role models) between intentions and behaviors according to Ajzen’s behavioral interventions based on the Theory of Planned Behavior (2006), so that virtual reality science game-based learning can achieve its full potential of

enhancing students' behaviors on proceeding with the scientific workforce. As a result, the total number of Americans preparing for scientific careers may increase, regardless of gender

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Generation Z Support to Autonomy in Education in Turkey: Evaluation of Teacher Candidates' Views

İbrahim Çankaya, Aycan Çiçek Sağlam, and Çetin Tan

Abstract

The aim of this study was to demonstrate the opinions of teacher candidates, who were born after 2000 and called Generation Z, about the concept of school autonomy. This quantitative research was conducted according to the descriptive survey model. The data obtained is based on the responses given by teacher candidates to the "School Autonomy" questionnaire that was prepared for school administrators as part of the 2012 PISA exam. Generation Z teacher candidates in general hold the opinion that the authority to make decisions should lie with the school when it comes to determining the annual school budget, making disciplinary decisions about students, evaluating students' success, accepting students to school, choosing textbooks and determining the courses to be taught. Teacher candidates also believe that the ministry, provincial education directorates and schools should cooperate in the selection of schools and determination of their annual salaries.

Keywords: Generation Z, teacher candidates, school autonomy, PISA

Dr. İbrahim Çankaya is an Associate Professor at Uşak University Education Faculty, Turkey. Dr. Cankaya can be reached at ibrahim.cankaya@usak.edu.tr

Dr. Aycan Çiçek Sağlam is a Professor at Muğla Sıtkı Koçman University Education Faculty, Turkey. Dr. Sağlam can be reached at aycancicek@mu.edu.tr

Dr. Çetin Tan is an Associate Professor at Fırat University Physical Education Faculty, Turkey. Dr. Tan can be reached at ctan@firat.edu.tr

Keeping up with change requires a flexible structure for organizations and personal development for individuals. Individuals' generation plays a very strong role in their beliefs, attitudes, thoughts and general views (Kayıhan & Erduran, 2017). A generation is defined as a community that has lived in the same historical period, has been affected by the same social events and has the same social identity. Each generation has different ways of perceiving life and styles of communication, its own characteristics, principles, strengths and weaknesses (Toeffler, 2018).

Generations of individuals are defined according to the years they were born in the 20th century and 21st century; "Generation X" includes individuals born between 1965-1979, "Generation Y" is comprised of individuals born between 1980-1999, and those born after 2000 are called as "Generation Z" (Yüksekbilgili, 2013). Generation X is described as a generation of emotional, idealistic, contentious, neat people who are open to change, educated and focused on their careers. They prefer watching movies to reading books (Senbir, 2004). Generation Y can be described as libertarian, intellectual and technologically capable individuals. Generation Y members are individuals who are independent, free, against authority, not restricted by the rules, not constrained by working hours, self-confident and want to climb career ladders as soon as possible. They dislike taking orders, reject impositions, have stubborn and rebellious characters. They love to be in social media and social environments and can engage in conflicts in line with their own ideas and wishes. (Bayraktar, 2017). Generation X is called an ideological generation, while generation Y is referred to as a pragmatist generation (Çetin and Karalar, 2016).

Individuals born from 2000 and onward are called members of Generation Z. Generation Z is also labelled as the "Digital Generation" (Somyürek, 2014). This generation, as the previous generation, is highly engaged in technology, and can even be said to be addicted to technology. Especially, today's ever-developing advanced smart devices and

internet infrastructure can cause the members of this generation to become addicted to technology (Kavalcı & Ünal, 2016). Generation Z is in the focus of the internet. This generation, which uses technology well, is younger than other generations. They can easily perform many tasks simultaneously (Golovinski, 2011). This brings Generation Z one step ahead of other generations. In a general sense, Generation Z has a pragmatic and realistic character. Compared to previous generations, they are more wary about taking risks. This entrepreneurial and more social generation consists of individuals who learn how to learn and are open to new technologies because they are raised surrounded by technology. It takes a very short time for the members of this generation to focus on any topic. Long texts and time-consuming and repetitive applications are boring for them (Penfold, 2017). The perspective of Generation Z regarding business life differs from previous generations. Among the expectations of the Generation Z from the working environment are flexibility in the workplace and working time, maintaining the work-life balance, the opportunity of both vertical and horizontal career advancement, the tasks in which technology is integrated, recognition for success, opportunities that offer moral rather than material satisfaction, and technological tools (Computer, internet etc.) made available to them (Arar, 2016). Due to its features, Generation Z can be considered as the generation of individuals who like to act individually in flexible organizations and can create an environment in which they can express themselves. Besides making money, job satisfaction, organizational justice and motivation are very important for this generation. They have the feature of adapting to the speed of knowledge and time, and these individuals pursue fun and continuous learning while working. These characteristics are directly related to flexible organizations, self-management and school autonomy (Seymen, 2017). This is because autonomous management approach and flexible organizational structure are dependent on individual talents and a participatory

management approach (Elma & Demir, 2017). Generation Z individuals born after 2000 and studying at universities will be assuming their roles in business life very soon.

Primary, secondary, high school and university students born after 2000 and named as the 'technology generation' are all members of Generation Z. Although there are different ideas in the literature regarding the personal characteristics of the new generation, teacher candidates who belong to Generation Z and who will be responsible for the education of the next generations (Kırık & Köyüstü, 2018), the studies conducted on the expectations of this generation regarding the teaching profession and school expectations are limited. Therefore, further research is needed to determine the opinions of Generation Z teacher candidates about the optimal structure of schools. New findings can shed light on educational policies, educational reforms, and teacher training processes. Identifying the opinions of Generation Z teacher candidates about school autonomy can serve as a guide to the restructuring of the school. In this study, the "School Autonomy" questionnaire prepared within the scope of the 2012 PISA exam for school administrators was administered to teacher candidates, and following questions were posed:

- Who should have the authority to make decisions in the appointment of teachers to a school?
- Who should have the authority to make decisions in determining annual teacher salary increase rates?
- Who should have the authority to make decisions in determining the annual school budget?
- Who should have the authority to make decisions in making disciplinary decisions?
- Who should have the authority to make decisions in assessing students' achievement?
- Who should have the authority to decisions on the students' admission to school?
- Who should have the authority to make decisions in determining the textbooks?
- Who should have the authority to make decisions in determining the courses to be taught in the school?

The answers given to the questions reflect the expectations of Generation Z about school autonomy or school-based management.

Methodology

This quantitative research was conducted according to the descriptive survey model. Survey model studies are aimed to make predictions and generalizations about the research through the method of sampling (Balci, 2018). The target population of study consisted of teacher candidates who studied with the Faculty of Education of Muğla Sıtkı Koçman University in the fall semester of the 2019-2020 academic years. In this study, no sample selection was made, and questionnaires were distributed to 351 teacher candidates. 107 of the questionnaires were returned.

Data Collection Tool

The data were collected through the "School Autonomy" questionnaire prepared for school administrators as part of the 2012 PISA exam. The school autonomy questionnaire form is composed of a 'school autonomy related to resource allocation category' and a 'school autonomy related to academic and program category'. In the category of school autonomy related to resource allocation, the items regarding determination of annual teacher salary and creation of annual school budget are included. The 'academic and program related school autonomy category' included prompts about choosing a teacher for the school, making disciplinary decisions about the students, evaluating the success of the students, accepting the students to the school, determining the textbooks and determining the courses to be taught (OECD, 2013).

Data Analysis

Regarding the eight items included in the school autonomy questionnaire, the teacher candidates replied to the question, "Who do you think should have authority?" by choosing one of the following: Ministry of Education, Provincial Directorate of National Education, or

The School Administration. Based on frequency and percentage analyses, the responses are shown in a percentage graphic.

Findings

After analyzing the responses given by teacher candidates, the findings related to gender, year of birth, and who should have the authority in choosing teachers for school, determining teacher salary increase rates, making the annual school budget, making disciplinary decisions about the students, evaluating student success, accepting students to school, determining the textbooks and determining the courses to be taught are shown in figures in this section.

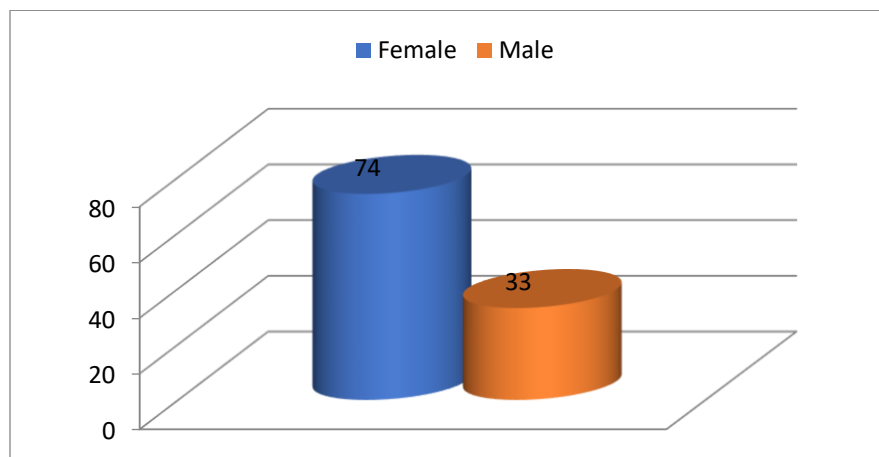


Figure 1. The Ratio of Teacher Candidates By Gender

As shown in Figure 1, 74% of the teacher candidates who participated in the research were female and 33% were male.

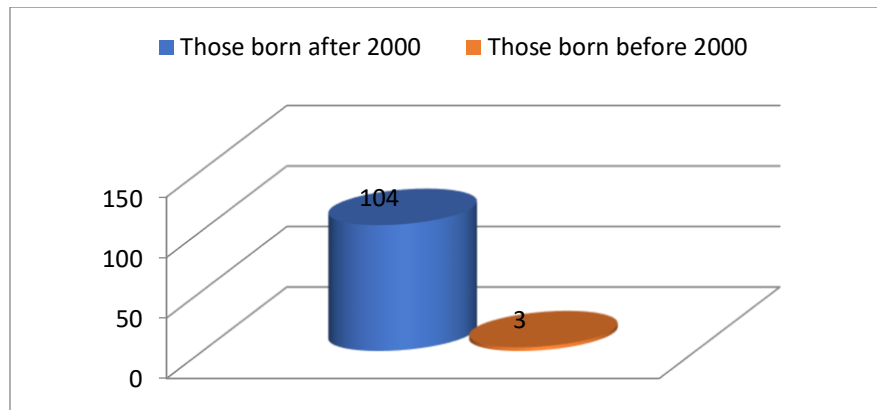


Figure 2. Pre-Service Teachers' Age Category

As shown in (figure 2) 97% of the teacher candidates who participated in the study were born in 2000 and afterwards (Generation Z), and 3% were born before 2000.

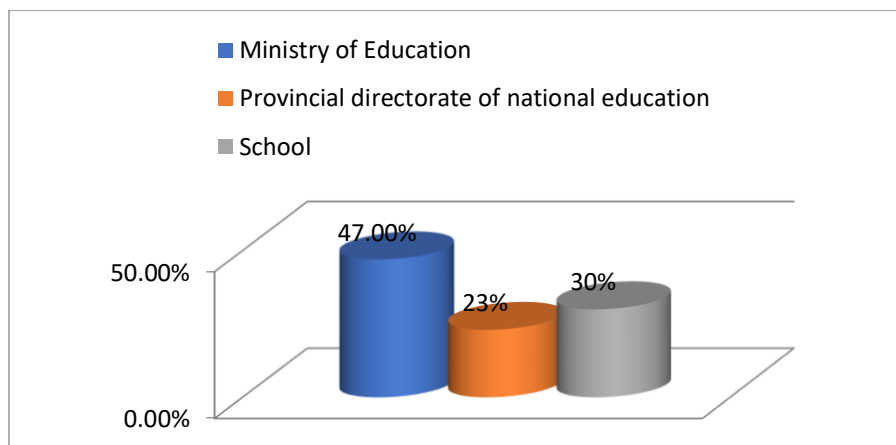


Figure 3. Authority of the School in Teacher Selection

As shown in Figure 3, 47% of the teacher candidates included in Generation Z were of the opinion that the decision-makers in the appointment of the teacher should be the ministry, while 30% thought that the schools should also have the authority to decide on the selection of teachers, and 23% stated that the authority regarding this issue should lie with the Provincial Offices of National Education. Overall, 53% of the teacher candidates in total emphasized that the school and local education elements should be involved in the decision-making process regarding the selection of teachers.

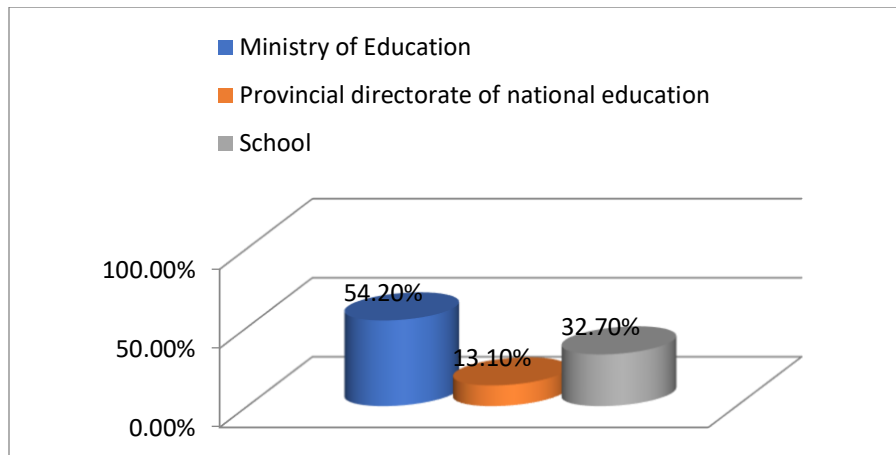


Figure 4. Authority in Determining Teacher Salary Increase Rates

As shown in Figure 4, 54.20% of Generation Z teacher candidates stated that the ministry should have the authority to determine teacher salary increase rates, while 32.70% expressed that the schools should also have the power to make decisions in determining the salary increase rates, and 13.10% replied that Provincial Offices of National Education should be the authority determining the rates of salary increase. It can be said that teacher candidates thought that not only the ministry but also the local stakeholders who make up the education system should be asked of their opinions and decisions should be made together.

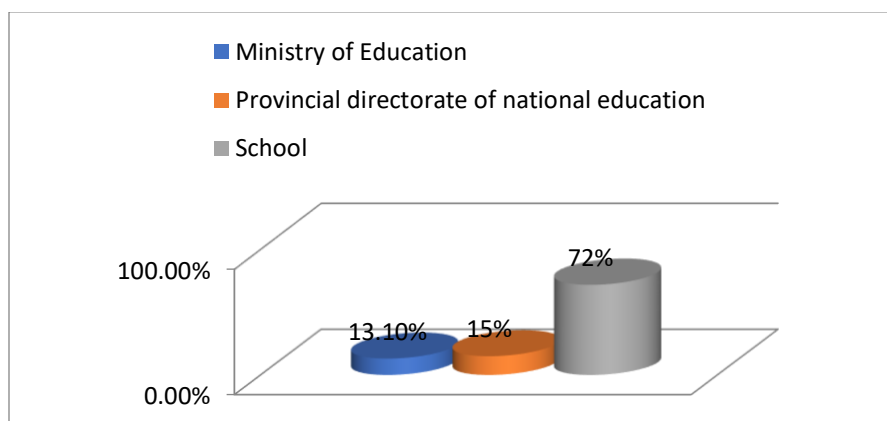


Figure 5. Authority to Determine The Annual School Budget

As shown in Figure 5, 72% of the teacher candidates stated that the decision-making authority regarding the determination of the annual school budget should be completely the school, 15% said the power to make decisions on this issue should be given to the Provincial

Offices of National Education, while only 13.10% believed that the ministry should be the authority. It was observed that the teacher candidates of Generation Z mostly advocated that the schools should be autonomous in determining the education budget.

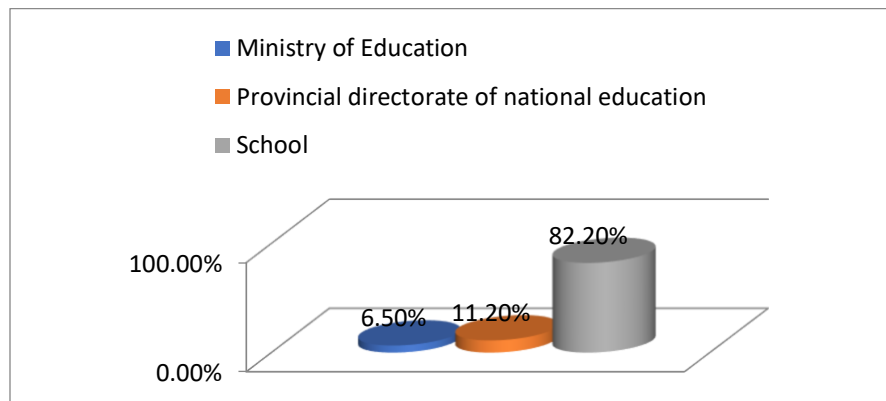


Figure 6. Authority to Make Disciplinary Decisions About Students

As shown in Figure 6, while 82.20% of the teacher candidates stated that the decision-making authority to punish undesirable student behavior and to reward students should lie only with the school, only 6.50% stated that the authority should lie with the ministry. The teacher candidates endorse the idea that the school should be autonomous about disciplinary decisions.

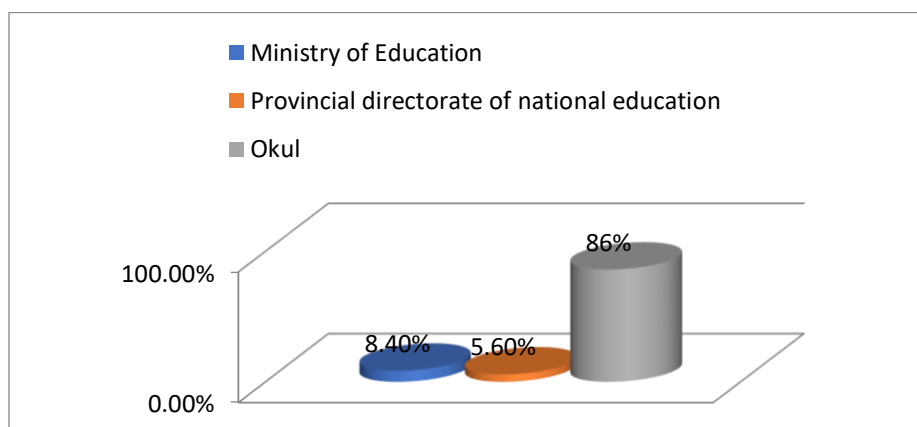


Figure 7. Authority To Make Decisions in Evaluating Student Success

As shown in Figure 7, 86% of the teacher candidates stated that the decision-making authority should completely rest in the school for evaluating students as successful or unsuccessful in passing the courses or classes. Only 8.40% of the teacher candidates

expressed that the power to make decisions about the assessment of success should be given to the ministry.

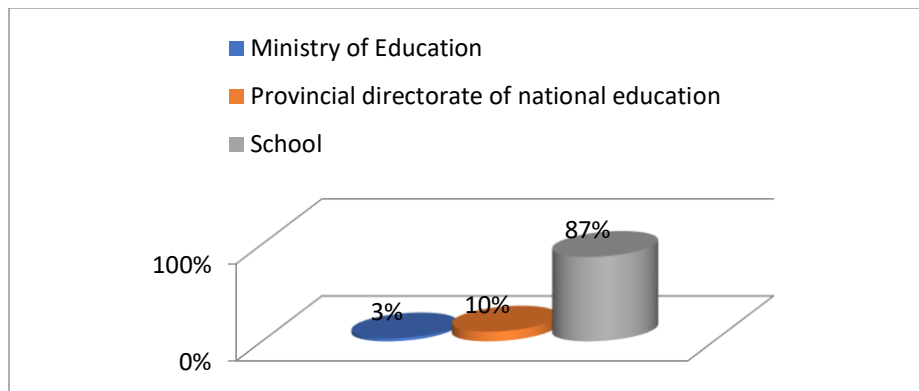


Figure 8. The Student's Authority to Decide on Admission

As shown in Figure 8, while 87% of the teacher candidates stated that the final decision should be made by the school regarding the admission of the student to the school, 10% argued that the decision should be left to the Provincial Offices of National Education, only 3% held the opinion that the decision should be at the disposal of the ministry.

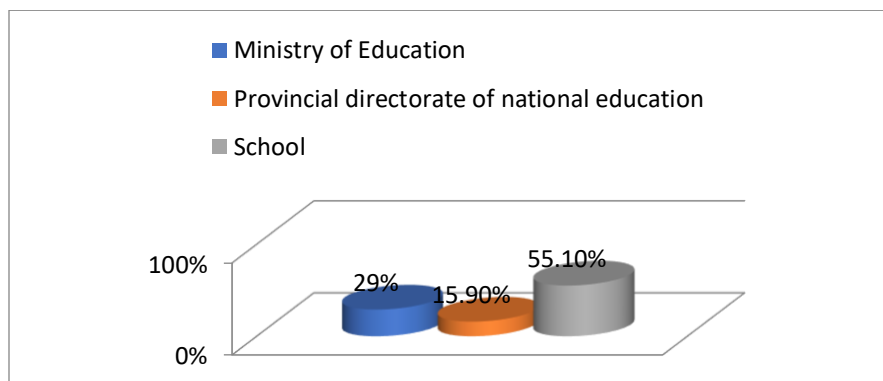


Figure 9. Authority in The Selection of Textbooks

As shown in Figure 9, while 55.10% of the teacher candidates stated that the school should be the authority in the selection of the textbooks to be taught, 29% said that the authority should be the ministry in the book selection, and 15.90% proposed that the Provincial Offices of National Education should be authorized regarding the matter. Teacher

candidates expressed the opinion that schools should also have the option of choosing books in addition to the common books determined by the ministry.

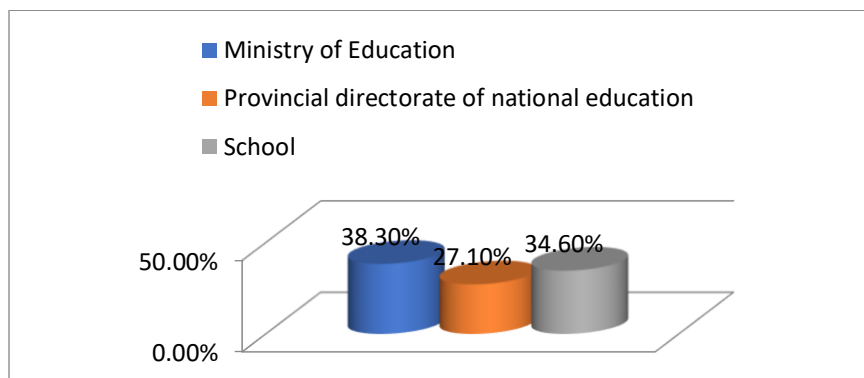


Figure 10. Authority to Decide Courses

As shown in Figure 10, 38.30% of the teacher candidates stated that the ministry should determine the courses to be taught in the school, 34.60% said the schools should decide, and 27.10% were of the opinion that the Provincial Offices of National Education should have the final say in this issue. Teacher candidates held the opinion that the ministry should be the determining factor in compulsory and elective courses in schools, but that the schools should also have the freedom of choice.

Discussion, Conclusion and Recommendations

The following conclusions can be drawn about the opinions of the teacher candidates in Generation Z: The teachers who will work in the school should not be appointed only by the ministry, but the school should also have the authority to make assessments regarding this issue. While approximately 54% of the teacher candidates think that the ministry should determine the annual salary increase rates, about 47% believe that the Provincial Offices of National Education and schools should be involved in the decisions to be taken. According to the teacher candidates in general, the school should be authorized to decide on the annual budget of the school. The school should have the authority regarding disciplinary decisions about students. The school should have the authority to decide on students' success and failure. The decision-making authority regarding the admission of the students should lie

within the school. The students' admission to the school should not be limited to the decision of the ministry. The teacher candidates hold the view that the ministry and Provincial Offices of National Education should have the power to make decisions, but the final decision should be left to the school. The teacher candidates have the view that both the ministry and the school should decide together in determining the courses to be taught.

The results of the research related to research on Generation Z from the literature. In his study, Penfold (2017) determined that 70% of Generation Z members wanted to be the manager of their own business and that 60% wanted to have a say in their profession. In his research, Golovinski (2011) determined that individuals from Generation Z want their job to be completed quickly and have the ability to do many things simultaneously. In their research, Taş, Demirdöğmez and Küçükoğlu (2017) found that Generation Z is a generation whose members express themselves more and want to participate in managerial decisions. Yelkikalan, Akatay and Altın (2010) determined that Generation Z is visionary, open to change and favors innovation. Kızıldağ (2019) identified that Generation Z university students have a participatory management approach. It is stated in the OECD (2013) report that schools should be more autonomous in decision making in education, according to the general view of school administrators. The personal characteristics of Generation Z identified in various studies are consistent with the teacher candidates' opinions about school autonomy and participation in the decision in this study.

From the perspective of Generation Z, the school should be empowered to make decisions for effective operation of the school, and hierarchical barriers to the school's participation in political decisions should be removed. For Generation Z teacher candidates, flexible school and school autonomy are a preferred business environment because Generation Z considers work motivation and enjoying work as very important. According to the expectations of Generation Z teacher candidates, schools should have autonomous

management, and the school should be at the very center of decision-making on issues related to education. The school should have more authority. The school should have an autonomous management outside the bureaucratic structure. The autonomous school approach seems to be compatible with the opinions of Generation Z.

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**Anecdotal Records:
A Successful Tool in the English Language Teaching and Learning**

Evangelin Arulselvi Whitehead

Abstract

A variety of strategies and tools are used to assess students' learning on an ongoing basis in the context of everyday classroom experiences. Assessment information provides the foundation for decision making and planning for instruction and learning. This paper discusses about using Anecdotal Records as a tool to observe students' progress in the learning of English language. Taken regularly, anecdotal records become not only a vehicle for planning instruction and documenting progress, but they also tell the story of every student. Students scored average and below average marks are the target participants of this study. The average and below average students of a particular course were selected based on their marks obtained in Quiz I and proper anecdotal records were maintained for these students to analyze their progress in studies throughout one full semester. The overall observation of the survey reveals the fact that maintaining anecdotal records is likely to encourage them to learn English language.

Keywords: Assessment tools, anecdotal records, teaching and learning.

Dr. Evangelin Arulselvi is Professor of English Language at the English Language Institute Of the Princess Nora Bint Abdulrahman University, Riyadh, Kingdom of Saudi Arabia. She can be reached at eva.arul@gmail.com

The world is advancing every day and students need to know not only the basic reading and arithmetic skills, but also skills that will allow them to face the challenges of the world. They should develop critical thinking skills and they must develop knowledge of analyzing and making inferences. Our students require educational goals that fit day to day challenges. These innovative learning goals change the relationship between the instruction and assessment. It is the high responsibility of the teachers to take active roles in making decisions about the purpose of assessment and the content that is being assessed. Research studies show that effective classroom assessment has a greater impact on student achievement than any other type of assessment. Assessment is an integral part of teaching, as it determines whether or not the goals of education are being met. Assessment has influence on the achievement and it affects decisions about grades, placement, advancement, instructional needs, curriculum, and, in some cases, funding.

Teacher observation and assessment inside and outside the classroom has been accepted directly as a legitimate source of information for recording and reporting student achievement of learning outcomes. Assessment involves observing and documenting children's overall personality development, their learning processes, experiences and relationships, and their effective interactions with the world around them. The purpose of assessment is to gather meaningful information about learners in their process of learning in order to make informed decisions to benefit their education and development. Teacher observation is directly capable of providing substantial information on student demonstration and achievement of learning outcomes at all levels of education. Teacher observation contributes to valid judgments concerning student learning outcomes and their achievements, evidence needs to be gathered and recorded systematically. Systematic gathering and recording of evidence of student progress requires preparation and foresight. Using a combination of various assessment techniques is generally best to gain a fuller understanding

of the student. Observational narrative techniques, also called anecdotal records, can result in a rich array of developmental information about individual student progress in learning that can be used in a variety of ways. The researcher has selected Anecdotal Records as such a tool to assess students' progress in English language learning.

Anecdotal Records

Among many observation tools, anecdotal record keeping is the best tool to observe students' progress in studies. The American Association of School Administrators define an anecdotal record as, "a written record kept in a positive tone of a child's progress based on milestones peculiar to that child's physical, social, economic, aesthetic and cognitive development." (AASA, 1992). Anecdotal records provide a longitudinal qualitative picture of the behavioral changes in the life of each student and this systematic recording is carried out overtime.

Rhodes and Nathenson-Mejia (1992) identified anecdotal records as a powerful tool for literacy assessment. Miller-Power (1996) argued that systematic, daily recording of children's actions was essential to generate focused instructional planning. Rollins-Hurely and Villamil-Tinajero (2001) used observational records to assess the language proficiency of English learners.

Baumann.J and Duffy-Hester, A. (2002) state that a fundamental purpose of assessment is to communicate what the child knows and is able to do. Teacher-generated, anecdotal records provide an insider's perspective of the child's educational experience.

Baker, L., Dreher, M.J., & Guthrie, J.T. (2000) identify that taking observational notes allows the teacher to record a wide range of authentic experiences and even unintended outcomes of literacy development. These notes are used to record objective and subjective information as well as affective information, such as levels of engagement, curiosity, and motivational factors

Grounlun (1985) asserts that anecdotal records provide a longitudinal qualitative picture of the behavioral changes in the life of each student. Omodara records about individual needs form a basis for decision making by aiding human memory. Anecdotal records are used to record the observed behaviors, skills and attitudes of individual learners as they relate to the outcomes in the program of studies. Anecdotes possess the advantage of being used to assess learners in the classroom lessons as well as outside the classroom activities. The record can be the description of the performance or events or activities going on in the class during the lessons and also it can be written in response to a product or performance that a learner has completed

Sax and Gillbert (1980) write that data obtained from anecdotes can be used to diagnose problems and hence ways of combating such problems. They can be used to develop behavioral norms. They are capable of enabling teachers to write valid and reliable reports or references about the pupils. This can be achieved through records of important episodes such as fight, quarrels, crying, failure to attempt or complete assignment, refusals to participate in games or other activities. Also truancy, cheating, shyness, fearfulness, suspiciousness, withdrawal, and other signs of emotional problems could be recorded as they occur.

Goodman (1985) mentions that evaluation provides the most significant information if it occurs continuously and simultaneously with the experiences in which the learning is taking place. Teachers who observe the development of language and knowledge in children in different settings become aware of important milestones in children's development that tests cannot reveal.

Anecdotal records are systematically kept notes of specific observations of individual student behaviors, skills and attitudes in the classroom and it relates to the outcomes in the program of studies. Anecdotal records give cumulative information regarding progress, skills

acquired by a student and directions for further instruction. Anecdotal notes are often recorded as the result of ongoing observations during the lessons but may also be written in response to a product or performance the student has completed. The notes recorded about a student are brief, objective and focused on specific outcomes. Notes taken during an activity or immediately after an activity are generally the most accurate. An anecdotal record is the observed behavior of a student in and outside the classroom. It is a record of some significant episode that happened in the life of the student in and outside the classroom that sheds light on the conducts, thinking, skills and capacities revealing significant features and characteristics about his/her personality. Anecdotal notes for a particular student can be periodically shared with that student or be shared at the student's request. These records can also be shared with students and parents at parent-teacher-student conferences.

The purpose of anecdotal notes is to:

- provide information regarding a student's development over a particular period.
- provide ongoing records about a student's instructional needs.
- capture observations of significant behavior of students that might otherwise be lost.
- provide ongoing documentation of learning that may be shared with students, parents and teachers.

Techniques for Writing Anecdotal Records

Reflecting about techniques for writing anecdotal records can positively affect both the content of the records as well as the ease with which they are recorded. Thorndike and Hagan (1977) suggested guidelines for the content of anecdotal records that teachers may find helpful.

- Describe a specific event or product.
- Report rather than evaluate or interpret.
- Relate the material to other facts that are known about the student.

Focus of the Study

The main aim of this study is to find out how anecdotal records are the most useful and successful tool in the undergraduate language teaching class rooms in Saudi Arabia. Usually, anecdotal records are not used effectively in the classrooms by the students and teachers. There is no record for a student's progress in studies. In reality, there are many students who drop a course due to the lack of knowledge of their own progress that leads to lack of confidence in a particular course. This situation led the researcher to find a proper method to motivate the students to continue in a course.

Proper maintenance of anecdotal records helps the teacher to observe individual students and their progress in studies. This observation helps the teacher to give suitable guidance as well as providing suitable materials and adapt suitable teaching strategies for improvement. Observing the anecdotal record of a particular student, the teacher gets a clear idea about the student. It also helps the student to analyze and observe her own progress for further improvement in her studies.

Methodology

To get the general idea of the use of anecdotal records, this research was conducted for one full semester during the Auiz II, first and second mid-terms and the final examination. Students who scored average and below average marks are the target participants of this study. Average and below average students were selected based on their marks obtained in Quiz I which was conducted for 10 marks. Forty students were selected for this survey and the researcher maintained a total record of all students personally.

Test Administration Procedure

The researcher prepared a table format of anecdotal record for each student. The researcher identified each student's educational needs. Students' profiles provided ideas for the researcher for collecting assessment information and give feedback about students'

learning outcomes. Based on the assessment, formative feedback was given to each student personally about their learning styles. The data collected by the researcher were related to the learning attitude of every student. Entries were made at regular intervals with the presence of the students followed by the guidance and advice given for the academic improvement of the selected students.

Observation and Analysis

Table -1 Performance in Quiz 1

Total number of students	69
Total number of students passed	35
Total number of students failed	34
Pass percentage	51
Fail percentage	49
Class average	5/10

Table -2 Performance in Quiz 1I

Total number of students	69
Total number of students passed	40
Total number of students failed	29
Pass percentage	58
Fail percentage	42
Class average	5.5/10

Table -3 Performance in Mid-term I

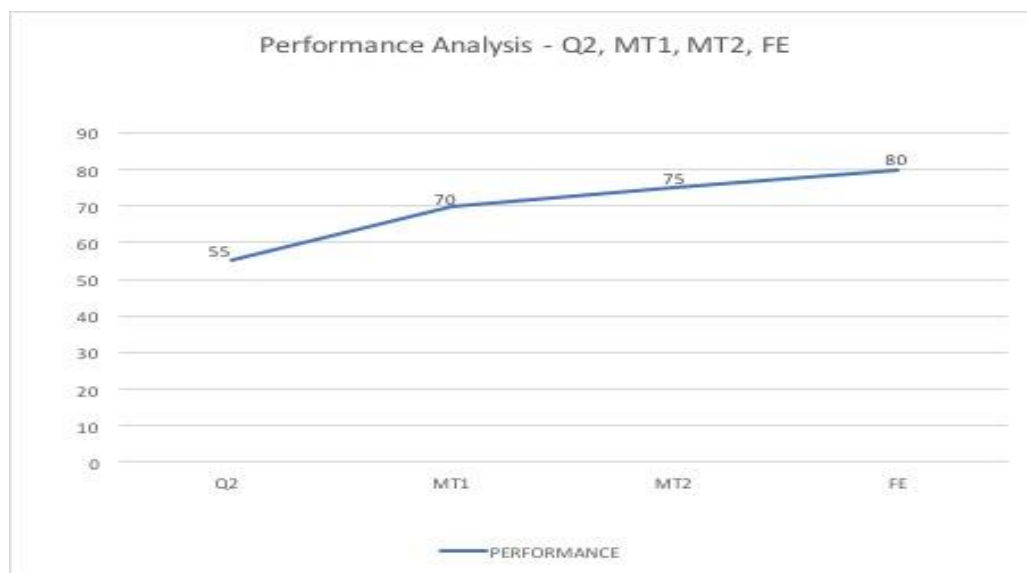
Total number of students	69
Total number of students passed	59
Total number of students failed	10
Pass percentage	85
Fail percentage	15
Class average	14/20

Table -4 Performance in Mid-term II

Total number of students	69
Total number of students passed	62
Total number of students failed	7
Pass percentage	90
Fail percentage	10
Class average	15/20

Table -5 Performance in the Final Examination

Total number of students	69
Total number of students passed	62
Total number of students failed	7
Pass percentage	90
Fail percentage	10
Class average	16/20

Graph 1 – Performance Analysis

The analysis of the average and below average students' performance was observed after Quiz II, Mid-term 1, Mid-term 2 and Final Examination. There was a gradual progress observed in the performance of the students. In Quiz II, the students' pass percentage was slightly improved and the average mean score of the class also had slight improvement. After

Quiz II, the selected students of the survey gained awareness that there was a record maintained by the researcher to observe their performance. This awareness created a positive impact on students to make further improvement in their studies which was evident in the results of the first Mid-term. In the first Mid-term, students' pass percentage was further improved with the moderate improvement in the average mean score of the total students' population. In the Mid-term II and Final examination, the pass percentage was the same, but in the final examination, there was improvement in the total mean score. The overall observation of the survey reveals the fact that maintaining anecdotal records is likely to encourage students to learn English language.

Suggestions for Using Anecdotal Records

Learners need to feel that their progress in studies is systematically recorded and maintained by the instructor. Anecdotal record assessment is informative to the parents and higher officials in that it compares the standards to the student's performance. Instructors must give open comments about students' progress in studies and they should create a chance for the students to meet their instructors whenever they need. With the help of anecdotal records, teachers observe the strengths, weakness and students' needs for further progress in their studies. Instructors must ensure quality of their instruction and encourage the students. Instructors must meet the students periodically and they should insist about the importance of time. They should provide valuable information sources. They must understand the students and be able to pinpoint the source of confusion.

Conclusion

Anecdotal records are a very useful tool for collecting information on an ongoing basis during instructions and evaluating the products of their instructions. Keeping anecdotal records on a regular basis can enhance a teacher's classroom observation skills. As a better practice of observing students in the classroom, the teacher can manage records, analyze observational

data, and provide standards-based recommendations. Anecdotal records give instructors a clear-cut idea about their students' progress in studies. They are advantageous not only for planning instruction but for keeping others informed of students' progress and for focusing future assessment. Keeping anecdotal records can become a natural and important part of teaching and learning. Anecdotal records facilitate communication between the children, their families, and educational professionals participating in the assessment process.

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Anecdotal Recording Form

Observer: -----	Observation Date:
Student Name: -----	
Observing Unit: -----	
Semester: -----	
Description of Student's progress	
Observer's Interpretation:	
Cognitive Development:	
Health and Ability	
Learning Outcomes/Class test Marks:	
Personal Incidents if any:	
Educational needs:	
General Comments:	

The Investigation of Middle School Student Learning Difficulties and Concept Misunderstandings in Multipliers and Factorization

Harun Dogrucan, Danyal Soybas, and Sevim Sevgi

Abstract

The aim of this study was to determine learning difficulties and misunderstanding in multipliers and factors of middle school students in Kayseri, Turkey. One hundred and seven students from 6th grade and 48 students from 8th grade were selected randomly from three middle schools for the study. A questionnaire, which was developed by the first researcher, including two open-ended questions, eleven multiple choice questions, and one true-false question was prepared for each group. Students solved each question and explained how they solved them. Also, it was requested verbally to fill in the solutions. Besides these questions, it was requested from the students to answer how they use the subjects of multiplication and factors in their daily lives and how these subjects affected their attitudes and treatments towards mathematics. According to the evaluations of this research, some suggestions were made for students' learning difficulties and concept misunderstanding about multipliers and factors.

Keywords: multipliers, factorization, concept, misconception, learning difficulties.

Harun Dogrucan is a mathematics teacher at a public school in Kayseri, Turkey. He works at the Ministry of National Education. He can be reached at hrrnmstf8414@gmail.com

Danyal Soybas is a professor in the Department of Mathematics and Science Education at Erciyes University, Turkey. He can be reached at danyal@erciyes.edu.tr

Sevim Sevgi is an assistant professor in the Department of Mathematics and Science Education at Erciyes University, Turkey. She can be reached at sevimsevgi@erciyes.edu.tr

Mathematics has a very wide range and includes interdisciplinary study; so mathematics in one discipline is closely related to many other disciplines (Baki, 2004). Learning mathematics helps students to get to know themselves, while at the same time preserving their life happenings. In addition, mathematics prepares them for the future by providing readiness to life, directs human life and helps people to adapt to the society in which they live (Bryk & Treisman, 2010). There is at least one target in each system that is intended to be achieved. From this point of view, the goals of mathematical instructional systems are the behaviors that are desired and planned to be gained by the students (Sönmez, 1998). Today, mathematics teaching is given regularly in schools, as well as in the natural environment of human beings. Also, teaching mathematics is a tool that makes our life easier. As a result of planned and tailored mathematics teaching activities, students can get to know life and be predictive about life.

There are many definitions of mathematics. It is much more useful to try to understand these definitions and not to see them as a kind of explanation (Baykul, 2011). It can be thought that the most important factor that separates mathematics from other courses is abstract structure. The concept is generally defined as a form of social and environmental factors that people imagine as objects and perceptions. Being able to make sense of objects and events in the mind can vary from person to person. Mathematical concept is defined as to categorize similar objects, people or situations (Senemoglu, 2005). While mathematic concepts come to life in our minds, it is also important that we interpret the actual situations in our minds. Interpreting these situations can also be related to our life. By nature, students are intertwined with social life. As a result of these experiences, interpreting events creates a reaction against them. Sometimes the situation in which students understand life and their life may not overlap. These situations may cause some difficulties in students' minds. The differences between the real situation and the situation played by the students in the teaching of mathematics can cause misconceptions. One of the biggest

problems that we encounter in teaching mathematics is misconceptions. Because misconceptions are situations that we accept correctly, but they do not exactly match reality. There are individual differences between students and these differences can lead them to learn in different ways. The use of appropriate methods and techniques in the learning of concepts can also reduce misconceptions that may occur in the student (Ozkan, 2017). Misconceptions may arise from the experiences and experiences of students in the past (Altınyüzük, 2008). Misconceptions are an important obstacle to real learning. Since misconceptions are accepted by the students, they do not try to correct them. More precisely, they are not aware that this information that they know is wrong. Misconceptions may be due to certain reasons. We can list some of these reasons as follows:

- Inability of the student to fully control the subject and to ensure the integrity of the meaning,
- The teacher is found to be antipathic by the students,
- The student's life causes him to perceive the subject differently,
- Not trying to fully understand the subject and not motivating the subject, and the
- Mathematics teacher also has misconceptions.

Students acquire many mathematical skills, and these skills are the product of learning (Erden, 2008). Mathematical learning can also be unconscious in some cases. To be able to realize mathematical learning because of events that come across during human life. The mathematical learning process is to create an activity or change a situation by reacting against a situation we encounter (Alkan & Kurt, 2007). Mathematical learning can also take place after this reaction.

Some Methods and Techniques Used in Mathematics Teaching

Many methods can be used for more permanent and effective learning in education. The purpose of these learning methods is the whole of the mental plans and methods used to realize

learning (Duman, 2009). Individual differences reflect and reveal one's own characteristics (Bacanli, 2012). In mathematics teaching, students can have a way of telling according to their understanding.

Method of instruction is a way that can be used when starting the course, summarizing long topics to large audiences or transferring information directly on any subject. It is generally transmitted through presentations (Demirel & Şahinel, 2006). Questioning method is based on the student's answers to the teacher's questions (Kuçukahmet, 1998). In this method, the teacher is the active leader of the class. The teacher should have a good command of the subject, know what (s)he is going to ask and should not ask questions that are beyond the purpose of the subject, disseminate the subject, nor bother the students. Teaching by invention is a method in learning through invention; the teacher is not in the center and the teacher does not give the concepts and principles directly to the student. Instead, the teacher helps students to create a beautiful learning environment for the student to access information (Baykul, 2009). Teaching by presentation is very superior to the method of plain expression. The student is active in this method. The teacher gives the student information systematically, and the student reaches a conclusion by establishing a relationship between what (s)he has learned and what (s)he will learn. In this method, the teacher has responsibilities. At the same time, the teacher must also have a superior rhetoric power here and should not bore students while presenting information. As a result, techniques and methods are used in teaching; mainly that the teachers are leaders of the class and the subject and give themselves to this task.

Elvan (2012) used a semi-experimental design model with pretest-posttest control group in a study with 57 students in total. He stated that the use of worksheets is beneficial, increases the participation of students in the lesson and is effective in reducing misconceptions. Başün (2016) carried out his study in a school in Samsun with a total of 42 students with two groups of

21 each. Results of the study demonstrate that there was a significant mean difference between the experimental and the control group students about the multipliers and factorization, and the subject of multipliers and factorization in the group taught by the game yielded more successful results and had higher averages than the group described by the appropriate teaching.

Furthermore, Damli (2011) utilized a pretest-posttest semi-experimental research model with experimental-control group in the research. He concluded that web-based interactive teaching is effective in eliminating misconceptions.

Research Problem

Mathematics is a science that helps people to think analytically in daily life and find practical solutions to the problems they face. For this reason, it is a science, which needs to be conveyed to students in a basic and regular way throughout their educational life. One of the biggest problems that teachers face in teaching mathematics is misconceptions. Multipliers and factorization are explained to students at the elementary level and related to other subjects, as in all other learning areas in mathematics. In this research, multipliers and factorization as well as misconceptions about this topic and learning difficulties were investigated and some solutions were proposed.

Aim of Study

Today, deficiencies in mathematics textbooks, the physical inadequacy of the classrooms, and reasons stemming from the teachers affect mathematics achievement in a negative way. In addition, the fact that the subjects in mathematics are related to each other and that the intelligibility of each subject affects other subjects also increases the importance of this course. In today's national education system, middle school is the time in which the foundation of mathematics is laid, and students begin to gain their mathematical skills. Multipliers and Factorization is one of the important issues that can be considered as the basis of many subjects

in mathematics and should be well understood. For this reason, Multipliers and Factorization should be explained thoroughly, and no misconceptions should be given. In this research, students' misconceptions about Multipliers and Factorization and learning difficulties caused by this were determined and the measures and solutions that can be taken against them were defined.

Research Questions

Multipliers and factorization are taught in both the sixth and eighth grade in middle school.

Objectives of this subject can be listed as follows:

- Determine the multipliers of natural numbers.
- Determine the factorization with natural numbers.
- Determine the common divisors of two natural numbers and their common multiples; solve related problems.
- Calculate the largest common divisor and the smallest common multiplier of two natural numbers; solve related problems (MoNE, 2013).

Limitations of this study are:

- The research was carried out in three middle schools in Kayseri, Turkey.
- The research was carried out in the spring semester of the 2017-2018 academic year.
- The research was carried out with 48 middle school students in 8th grade and 107 middle school students in 6th grade for a total 155 middle school students.

Hypotheses of this study are:

- Middle school students at the sixth grade have learning difficulties and misconceptions about Multipliers and Factorization.
- Middle school students at the eighth grade have learning difficulties and misconceptions about Multipliers and Factorization.

Assumptions of the study are:

- The students were not affected by each other during the administration of questions,
- Students were not affected by their mathematics teachers during the administration of questions,
- All students were taught in accordance with the middle school mathematics curriculum,
- All students willingly responded to the questions,
- All students answered the questions voluntarily,
- Physical conditions for the students were made suitable during the research.

Method

This is a descriptive study from general screening models since it is aimed to determine learning difficulties and misconceptions about multiples and factorization. In the descriptive method, the aim is to define and make a quantitative description of a situation or event that happened in the past or present (Fraenkel, Wallen, & Hyun, 2011).

Subject Sampling

When conducting research, all of the elements that are required to generalize the results can be called universal (Karasar, 2009). The population of this research consisted of sixth and eighth grade students in a middle school. The sample consisted of 48 eighth grade students and 107 sixth grade students in the three middle schools in the Melikgazi of Kayseri, Turkey. The students participating in the research were administered a test including multiple choice, true, false, open-ended questions and their views on multipliers and factorization.

Instruments

While conducting this research, tests were used to collect data and the opinions of mathematics teachers were taken into consideration. In addition, questions were prepared with high validity and reliability. In this research, a test was prepared at the 6th and 8th grade level and

these tests were prepared in a way that the students could answer in one hour. At the same time, all the situations in which the students would be negatively affected were considered and the effects of these situations were eliminated. In addition, before the test was applied to the students, general information about the research was given and the importance and purpose of the research was explained to the students and suggestions were made to give confidentiality of answers. These explanations made us think that the students would give realistic answers.

Analysis of Data

In this research, the Microsoft Office Excel program was used to analyze the test given to students. Frequencies, percentages, and standard deviations of the questions in the tests were calculated. By considering these data, all questions were interpreted one by one and misconceptions about multipliers and factorization were determined.

Results

Sixth Grade Questions and Answers

The research questions and the analysis of the answers given by the 6th grade students are as follows. The first question is given in Figure 1.

1) Enter all the multipliers of the numbers given below.		
I.	6	_____→
II.	12	_____→
III.	15	_____→
IV.	20	_____→
Explanation:		

Figure 1. Question 1 of the Test

Table 1. The analysis of the answers given by 6th grade students to the first question.

Options	0	1	2	3	4	5	6	Right Answer	
	Points	Point	Points	Points	Points	Points	Points	%	SD
1a	3	3	4	10	87	-	-	81.31	36.79
1b	2	3	3	2	3	12	82	76.64	29.63
1c	2	5	2	13	85	-	-	79.44	35.84
1d	2	4	4	6	12	10	69	64.49	23.95

The comprehensibility of the students' multiplier issue was tested with the first question. In the first question, the prime factors of the number six were asked, and the students were expected to answer 1, 2, 3, 6. The number of students who found all four factors was 87, the number of students who answered three of factors correctly was 10, the number of students who found two factors was four, the number of students who found one factor was three, while the number of students who could not find any factor was three. The proportion of students who answered all the factors correctly corresponds to 81.3%. In 1b, students were asked to supply multipliers of 12 (the numbers 1, 2, 3, 4, 6, 12), and 82 of them answered all the factors correctly. Twelve students gave five correct answers. There were three students with four correct factors, two students with three correct factors, three students with two correct factors, three students with one correct factor, two students who could not find any factor. The proportion of students who answered all correctly was 76.6%. In the question of multipliers of 15 in 1c, students should have answered 1, 3, 5, 15. Eighty-five students found all the factors. Thirteen students answered three factors, two students answered two factors, five students answered one factor correctly, while two students could not find any factor. The ratio of students who

answered all correctly was 79.4%. In 1d, students were asked to find the multipliers of the number 20 (1, 2, 4, 5, 10, 20). The number of students who answered all correctly was 69. There were 10 students with five factors, 12 students with four factors, six students with three factors, four students with two factors, and four students with one factor. The number of students who could not find a multiplier was two. The proportion of students who answered all correctly was 64.5%. When the results were examined for the first question, it was observed that the number of students who answered all the answers correctly was less than the other questions.

Question 2 for the sixth graders is in Figure 2 and the answer distribution of this question is in Table 2.

2) Write the first 3 multiples of the numbers given below.	
8	—————→
17	—————→
20	—————→
25	—————→
Explanation:	

Figure 2. Question 2 of the test

Table 1. The analysis of the answers given by the sixth grade students to the second question

Options	0 Points	1 Point	2 Points	3 Points	Right Answer Percentage	SD
2a	5	13	7	82	76.64	36.99
2b	5	16	11	75	70.09	32.48
2c	8	11	8	80	74.77	35.53
2d	5	14	11	77	71.96	33.71

In the second question, students were given some numbers and asked to find the first three multiples of these numbers. In 2a, while the number of students who found the first three

levels was 82, seven students with two factors, 13 students with one factor, five students did not answer the question at all. 76.6 percent of students answered all questions correctly. This is quite a high rate for students. In 2b, 75 students answered all factors, 11 students answered two factors, 16 students answered one factor, and five students did not answer the question. The percentage of students who answered all the factors correctly was 70.1%. In this question, it was observed that some students understood the logic of the question but made a transaction error while multiplying the number 17. This shows that students should know the multiplication at the level of multipliers and factorization and that mathematics is an additive course and the lack of a subject affects other topics. In 2c, the first three factors of the number 20 were asked, and the number of students who answered all correctly was 80. The number of students with two factors was eight, the number of students with one factor was 11, and the number of students with no factor answer was 8. 74.8% of the students answered the first three factors correctly. In 2d, the number of students who answered the first three factors of the number 25 was 77, the number of students who responded with two factors was 11, the number of students who answered one factor correctly was 14, and five students left the question blank. The percentage of students who found all was 72%. In general, when the first two questions were examined, it was observed that the middle school students' comprehension of multiples and multiples of numbers is close.

The questions 3 to 10 are given in Table 3. The answer distribution to these questions is in Table 4.

Table 3. Questions 3 to 10

3) What is the smallest multiple of 12 that is greater than 50? A)50 B)51 C)59 D)50 Solution and Explanation:
4) What is the maximum multiple of 15 that is less than 60? A)45 B)59 C)60 D)75 Solution and Explanation:
5) Which of the following numbers is the common multiplier of 15 and 20? A)2 B)3 C)4 D)5 Solution and Explanation:
6) Which of the following numbers is the common multiplier of all numbers? A)1 B)2 C)3 D)4 Solution and Explanation:
7) Which of the following numbers is not a multiple of 50? A)2 B)3 C)5 D)10 Solution and Explanation:
8) Which of the following is not a multiple of 13? A)26 B)39 C)52 D)64 Solution and Explanation:
9) How many times does the number 7 go into between 80 and 90? A)1 B)2 C)3 D)4 Solution and Explanation:
10) {1, 2, 3, 4, 6, 12} What is the number given above? A)12 B)15 C)18 D)24 Solution and Explanation:

In the third question, the students were asked for the multiples of the number, while four of them marked A, five of them marked B, and four of marked C, while 94 marked the correct answer option D and no student left the question blank. When we convert the data to percentages, 3.7% of the students participating in the study marked A, 4.7% marked B, 3.7% marked C, while 87.9% answered the question correctly. As this question was one of the introductory questions of multipliers and factorization, it was generally well understood and the correct answer rate was high. It is believed that the students who marked 51 were approaching with the first number logic exceeding 50 and responded incorrectly because they did not read the question carefully. The fourth question, was asked to be solved with a logic like the third question. The correct answer, option A, was chosen by 88 students, 6 of them marked B, 5 of

them marked C, 6 students marked D, and 2 students left the question blank. When we convert the data to percentages, 82.2% of the students participating in the study marked A, 5.6% marked B, 4.7% marked C, and 5.6% marked D. When the answers of the students are examined, it is observed that the correct answers to the third question and this question are close to each other, and a large part of the students answered the question correctly. It is thought that the students who marked the number 59 in the fourth question were wrong because of the expression "less than 60". In the fifth question, students were asked to find common divisors of numbers. When the answers given by the students were examined, it was seen that none of the students marked A and C options. Two students marked B, 104 students marked D, which is the correct answer, and 1 student did not answer the question. When the data is converted to a percentage, 1.9% answered B, 97.2% answered D, while 0.9% did not answer the question. It is thought that most of the students gave the correct answer to the fifth question because it was well understood, and it is an easy question. In the sixth question, the students were asked whether they know the rule that one divides all numbers. When the answers were analyzed, it was seen that 99 students marked option A, 5 students marked option B, one student marked option C, and two students marked option D. When we convert the data to percentages, it was observed that option A was chosen by 92.5%, option B was chosen by 4.7%, option C was chosen by 0.9%, and option D was chosen by 1.9%. It is thought that the number of correct answers to this question is because the fact that one divides all of the numbers is well understood. In the seventh question, the students were asked to find the factors of the number and the answers given by the students were as follows. Six students chose option A, 97 students chose option B, three students chose option D, and one student did not answer the question. This is to say that 5.6% chose option A, 90.7% chose option B, 2.8% chose option D, and 0.9% of students did not give any answer. In the eighth question, the multipliers objective of the sixth grade was tested and when the answers

given by the students were examined, it was seen that only one student marked option A, three students marked option B, four students marked option C, and 99 students marked option D.

When we convert the number of options marked to percentage, students chose option A by 0.9%, option B by 2.8%, option C by 3.7%, and option D by 92.5%. The fact that the rate of correct answers to this question is high is thought to stem from the problem. In the ninth question, students were asked about the multiple of the number and this number was limited to a strict range. When the answers given by the students to the question were examined, it was observed that 86 students marked option A, five students marked option B, 10 students marked C option, three students marked D option, while three students did not answer the question. When we convert the data to percentages, 80.4% chose option A, 4.7% chose option B, 9.3% chose option C, and 2.8% chose option D, while 2.8% of students did not give any answer to the question. In the tenth question, the multipliers of the number were given to the students, and the number with these multipliers was asked. When the answers given by the students to the question were examined, it was observed that 94 students marked A, three students marked C, six students marked D, while four students did not answer the question. When we turn the data into a percentage, it is seen that 87.9% of students chose A, 2.8% chose option C, and 5.6% of students chose D, while 3.7% of students did not answer any questions. The reason why the D option was the most frequent wrong answer is that students think that the elements of this set belong to 24, and they do not realize what the number must be in order to be 24.

Table 4. The analysis of the answers given for the 3rd to 10th questions by the 6th grade students

Question	Option A	Option B	Option C	Option D	Empty	Right Answer %	SD
3	4	5	4	94*	0	87.85	40.63
4	88*	6	5	6	2	82.24	37.27
5	0	2	0	104*	1	97.20	46.18
6	99*	5	1	2	0	92.52	43.42
7	6	97*	0	3	1	90.65	42.32
8	1	3	4	99*	0	92.52	43.41
9	86*	5	10	3	3	80.37	36.23
10	94*	0	3	6	4	87.85	40.64

Question 11 is given in Figure 3. Answers to this question 11 is in Table 5.

- 11) Write R at the beginning of each statement for the correct statements and W for the incorrect statements.
- () The number 2 is a multiplier of the number 10.
 - () The number 5 is a divisor of the number 15.
 - () Each number is its own multiplier.
 - () The number 1 is a divisor for each number.
 - () 2 is the divisor of all even numbers.
 - () 3 is the divisor of all odd numbers.

Figure 3. Question 11

In the eleventh question, the students were expected to answer the right and wrong questions about Multipliers and Factorization. When the answers given by the students are

examined, the number of students who answered all six questions correctly was 71, the number of students who answered five questions correctly was 25, the number of students who answered four questions correctly was seven, the number of students who answered three questions correctly was three, and one student answered two questions correctly. When we convert the data to percentage, the ratio of students who answered all questions correctly was 66.4%, the ratio of students who answered five correctly was 23.4%, the ratio of students who answered four correctly was 6.5%, and the ratio of students who answered three correctly was 2.8%.

Table 5. The analysis of the 6th grade students' answers to the 11th question

Question	0 Points	1 Point	2 Points	3 Points	4 Points	5 Points	6 Points	Right Answer %	SD
11	0	0	1	3	7	25	71	66.36	26.11

In the twelfth question, the question of multipliers of the number was asked to the students as a problem.

12) Ahmet paid 2500 TL for a television. He wants to pay in equal installments. How many TL can Ahmet pay? A)150 B)200 C)250 D)300 Solution and Explanation:
13) How many people can be in a tourist group that can be divided into groups of 3 and 4? A)20 B)40 C)60 D)80 Solution and Explanation:
14) If Ayşe wants to divide 28 liters of olive oil into equal containers, how many containers does she need? A)3 B)4 C)5 D)6 Solution and Explanation:

Figure 4. Questions 12 to 14

Students were asked to find the multipliers of 2,500. When the students' responses to the question were examined, it was observed that five students marked A, three students marked B, 90 students marked C, five students marked D, and four students did not answer the question. When we turn the data into percentages, it is seen that 4.7% chose option A, 2.8% chose option B, 84.1% chose option C, 4.7% chose option D, while 3.7% of the students did not give any answer to the question. In the thirteenth question, the question of the multipliers of the number was asked of the students. When the students' responses to the question were examined, it was observed that six students marked A, four students marked B, 95 students marked C, and two students did not answer the question. When we turn the data into percentages, it is seen that students marked A by 5.6%, B by 3.7%, and C by 88.8%, while 1.9% of the students did not answer any questions. In the fourteenth question, the question of multipliers of the number was asked to the students as a problem. When the answers given by the students to the question are examined, it is seen that one student marked A, 98 students marked B, two students marked C, and four students marked D. It was observed that two students did not answer the question. When we convert this data to percentages, students choose A as 0.9%, B as 91.6%, C as 1.9%, and D as 3.7%. 1.9% of the students did not give any answer to the question.

The analysis of the answers given by 6th grade students to questions 12 to 14 are given at Table 6.

Table 6. The analysis of the answers given by 6th grade students to questions 12 to 14

Question	Option A	Option B	Option C	Option D	Empty	Right Answer %	SD
12	5	3	90*	5	4	84.11	38.36
13	6	4	95*	0	2	88.79	41.20
14	1	98*	2	4	2	91.59	42.83

When the questions were considered, it was thought that multipliers and multiples are generally understood at the 6th grade level. The high percentage of respondents who answered correctly in most of the questions is the biggest indicator of this. A good understanding of this issue is thought to affect other issues. This is because mathematics is a course of interrelated subjects and forms the basis of many topics in multipliers and multiples.

At the end of all questions, the students were asked to interpret this topic in order to measure whether the logic of this subject was understood, and they were asked a question, "After you have been told by your teacher about Multipliers and Factorization, you can relate this subject to what you have in your lives and how do you think this subject affects your attitude and behavior towards mathematics lesson?" An example of the responses received from the students is as follows in Figure 5.

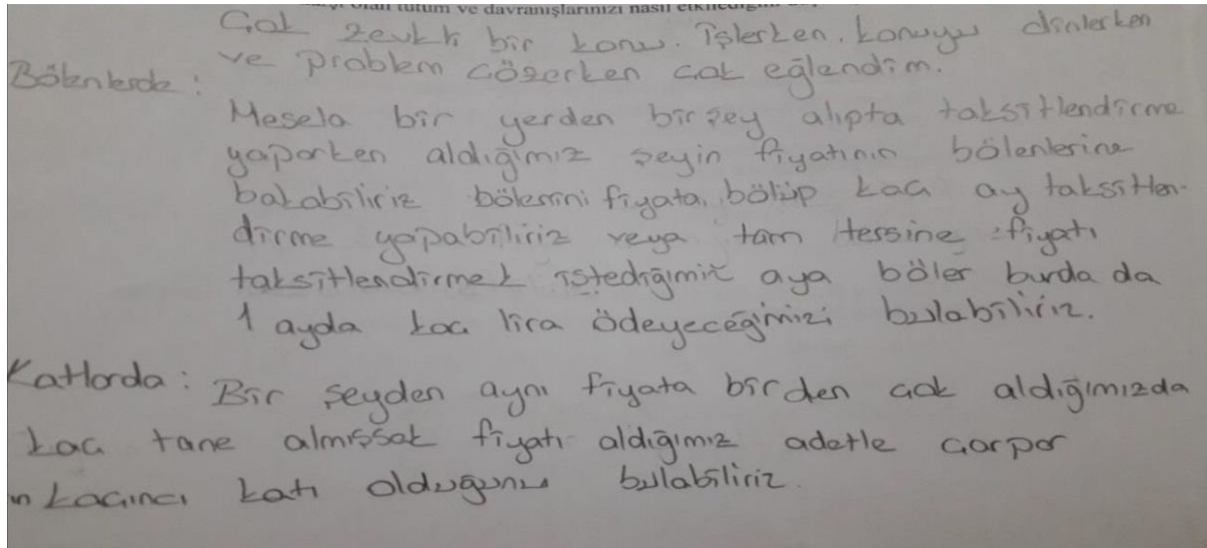


Figure 5. The example response received by the 6th grade middle school students on the multipliers and factorization

Eighth Grade Questions and Answers

The questions asked to the 8th grade students and their analysis are as follows. The first question is given in Figure 6. Eighth grade middle school students' answers to the first question are given in Table 7. In the first question, tested the comprehensibility of the Multipliers of Numbers subject which was explained to the students. Although the numbers in the four options are different from each other, they are questions to be solved with the same solution strategy. Since the number 23 in 1a is the prime number, it is only the factor of 1 and the number itself. The number of students who found these two multipliers was 35 students. The number of students who found only one of them was four, and the number of students who could not find any factor was nine. Furthermore, 72.9% of students wrote 2 multipliers. In 1b, when the answers given by the students to the factors of the number 16 were examined, the number of students who found all the factors of 1, 2, 4, 8, 16 were 34 students, four students wrote four factors, and two students found five factors. Eight students could not find any of the multipliers. The proportion of those who answered all correctly was 70.8%. When students' responses to the

factors of 25 were examined in 1c, 35 students found all the factors of 1, 5 and 25. Two students found two factors, and one student found one factor. Ten of the students could not find any factor. The percentage of students who found it all was 72.9%. In 1d, when the answers given by students were examined, 24 students found all the factors of 1, 2, 3, 4, 6, and 12. Six students found five, eight students four, and one student found one. There were nine students who did not answer any questions. This means that 50% of students found all of the multipliers correctly. When the answers given to these four questions are examined, it is understood from the high percentages that the subject is generally understood.

1) Enter all the multipliers of the numbers given below.			
I.	23	_____	→
II.	16	_____	→
III.	25	_____	→
IV.	12	_____	→
Explanation:			

Figure 6. Question 1

Table 7. The analysis of the answers given by the 8th grade students to the first question.

Options	0 Point	1 Point	2 Points	3 Points	4 Points	5 Points	6 Points	Right Answer %	SD
I.	9	4	35	-	-	-	-	72.92	16.64
II.	8	2	0	0	4	34	-	70.83	13.08
III.	10	1	2	35	-	-	-	72.92	15.85
IV.	9	1	0	0	8	6	24	50.00	8.45

The second question, which was administered to eighth grade middle school students is given in Figure 7.

2) Write the first 4 times of the numbers given below.	
13	_____→
15	_____→
17	_____→
20	_____→
Explanation:	

Figure 7. Second question of test

The answers of the eighth grade middle school students to the second question is in Table 8. In the second question, the comprehensibility of the multiples was tested. In 2a, the number of students who answered the first four multipliers of the number 13 correctly was 21, the number of students who answered the three correctly was three, the number of students who answered two correctly was three, and the number of students who answered one correctly was 13. The number of students who did not answer the question was eight. In this question, the percentage of students who answered all correctly was 43.8%. In 2b, the number of students who answered the first four times of the number 15 correctly was 20, the number of students who answered three correctly was four, the number of students who answered two correctly was three, the number of students who answered one correctly was nine, and the number of students who could not answer the question was 12. In this question, the percentage of students who answered all correctly was found to be 41.7%. When we look at 2c, the number of students who answered the four correctly was 18, the number of students who answered three correctly was six, the number of students who answered two correctly was three, the number of students who answered one correctly was eight, and the number of students who did not answer the question was 13. In this question, the percentage of students who answered all correctly was 37.5%. It is thought that the reason for the low number of correct answers to this question is because the number 17 is less common and less familiar than the other numbers. When we look at 2d, the number of students who answered the first four times of 20 correctly was 21, the number of students who answered three correctly was

four, the number of students who knew two correctly was two, the number of students who answered one correctly was nine, and the number of students who did not answer the question was 12. In this question, the ratio of students who answered all correctly was 43.8%.

Table 8. The analysis of the answers given by the 8th grade students to the second question.

Options	0 Point	1 Point	2 Points	3 Points	4 Points	5 Points	Right Answer %	SD
2a	8		13	3	3	21	43.75	7.60
2b	12		9	3	4	20	41.67	6.88
2c	13		8	3	6	18	37.50	5.94
2d	12		9	2	4	21	43.75	7.50

In general, when the first two questions were examined, it was observed that the middle school students' comprehension of multiples and multiples of numbers is close. Questions 3 to 10 are given in Table 9. The analysis of the answers by 8th grade students given to questions 3 to 10 were given at Table 10.

Table 9. Questions 3 to 10

3) What is the smallest multiple of number 13 greater than 50? A) 50 B) 51 C) 52 D) 53 Solution and explanation:
4) What is the largest multiple of 17 below 60? A) 45 B) 50 C) 51 D) 52 Solution and explanation:
5) Which of the following numbers is the common multiplier of 18 and 28? A) 2 B) 3 C) 4 D) 5 Solution and explanation:
6) Which of the following numbers is the common multiplier of all numbers? A) 1 B) 2 C) 3 D) 4 Solution and explanation:
7) Which number is not a multiple of 100? A) 2 B) 3 C) 5 D) 10 Solution and explanation:
8) 102:a is an integer. What is a? A) 2 B) 4 C) 8 D) 12 Solution and explanation:
9) How many common multipliers do the numbers 16 and 20 have? A) 1 B) 2 C) 3 D) 4 Solution and explanation:

In the third question, the situation of determining the multiples was measured. In this question, two students selected A, six students selected B, 32 students selected C, three students selected D, and five students preferred not to answer the question. When we convert the data to percentage, option A was chosen by 4.2%, option B by 12.5%, the correct answer was C with 66.7%, and option D was 6.3%, while the percentage of students who did not respond was 10.4%. The fact that the correct markers were 66.7% indicated that the problem was generally well understood. It was thought that the most marked option B, after the correct answer, was chosen because students marked the “the number greater than 50 is 51” without thinking carefully about the question. In the fourth question, the situation of determining the multiples of the students was determined. In this question, two of the students marked A, five of them B, 34 of them C, five of them chose D, and two students chose not to answer the question. When we convert the data to percentage, option A corresponds to 4.2%, option B to 10.4%, option C to

70.8%, and option D to 10.4%, while the percentage of students who did not respond is 4.2%.

Another feature that draws attention to this question is that the problem was similar to the previous question and the ratio of those who gave the correct answer was close, which might give clues about the reliability of the research. In the fifth question, students were asked to determine the multipliers of the numbers and find the common ones. In this question, 41 students marked A, two students B, four students C, and one student D selected. When we turn the data into a percentage, it is seen that the correct answer was 85.4%, B was 4.2%, C was 8.3%, and D was 2.1%. The fact that 85.4% of the answers were correct shows that the problem was generally understood. In the sixth question, students demonstrated their skills to find divisors of numbers. In this question, 41 students marked A, four students marked B, two students marked C, and one student selected D. When we convert the data to percentages, students marked the correct answer option A at 85.4%, option B at 8.3%, option C at 4.2%, and D at 2.1%. The fact that 85.4% of the answers were correct shows that the problem was generally understood. In the seventh question, students were directed to find divisors of numbers. In this question, one student marked A, 38 students marked B, two students marked C, and seven students selected D. When we convert the data to percentages, option A was 2.1% (correct answer), option B was 79.2%, option C was 4.2% and option D was 14.6%. The fact that 79.2% answered correctly indicates that the problem was generally understood. In the eighth question, the students were asked to find the divisors of the numbers. In this question, 26 students marked A, two students B, one student C, 10 students selected D, and nine students preferred not to answer the question. When we turn the data into a percentages, it showed that the students marked the correct answer option A at the rate of 54.2%, option B at 4.2%, option C at 2.1% and option D at 20.8%, while the percentage of students who did not answer was 18.8%. Although the question is not a difficult question, the way the question is asked indirectly may mislead the students. In the ninth question, it was aimed

to find the divisors of the students and to grasp the common ones. In this question, six students marked A, 21 students marked B, 17 students selected C, and three students was selected D, and one student did not choose to answer the question. When we convert the data to percentages, option A was 12.5%, option B was 43.8%, the correct answer was 35.4%, option D was 6.3%, while the percentage of students who did not answer was 2.1%. Although the students who gave wrong answers from the students did not give much explanation, when the papers were examined, it is thought that the most wrong answer was 2. Because both numbers were double, this might have caused an error for the students, or the students may have found the numbers two and four and forgot the number one, which was generally overlooked.

Table 10. The analysis of the answers by 8th grade students given to questions 3 to 9

Question	Option A	Option B	Option C	Option D	Empty	Right Answer %	SD
3	2	6	32*	3	5	66.67	12.62
4	2	5	34*	5	2	70.83	13.72
5	41*	2	4	1	0	85.42	17.62
6	41*	4	2	1	0	85.42	17.62
7	1	38*	2	7		0	79.17
8	26*	2	1	10	9	54.17	10.01
9	6	21	17*	3	1	43.75	8.88

10) Write R at the beginning of each statement for the correct statements and W for the incorrect statements.

() The number 3 is the multiplier of the number 33.

() The number 7 is the divisor of the number 49.

() Each number is its multiplier.

() The number 1 is the divisor of each number.

() 2 is the divisor of all even numbers.

() 3 is the divisor of all odd numbers.

Figure 6. Question 10

Table 11. The analysis of the 8th grade students' answers to the 10th question

	0 Point	1 Point	2 Points	3 Points	4 Points	5 Points	6 Points	Right Answer %	SD
10	0	0	0	4	6	20	18	41.67	8.63

Question 10 is given in Figure 6. The analysis of the 8th grade students' answers to the 10th question were given at Table 11. In the tenth question, six questions were asked to the students about the factors and multiples and they were asked to write R (right) next to the questions they thought were correct and W (wrong) next to the questions they thought were wrong. The number of students who answered all questions correctly was 18, the number of students who made five correctly was 20, the number of students who made four correct was six, and four of the students who made three correct. In this question, the ratio of students who answered all questions correctly was 37.5%.

11) Ahmet paid 2000 TL for a television. He wants to pay in equal installments. How many TL can Ahmet pay? A)150 B)200 C)300 D)350 Solution and Explanation:
12) How many students can be in a class that can be divided into groups of 2, 3 and 5? A)15 B)20 C)25 D)30 Solution and Explanation:
13) Ali has 27 walnuts. Ali cannot separate the walnuts into groups? A)1 B)3 C)9 D)18 Solution and Explanation:
14) It is desired to put 15, 20 and 25-liter milk into bottles of equal volume without mixing them together. How many liters can the bottle be used for this? A)2 B)3 C)4 D)5 Solution and Explanation:

Figure 7. Questions 11 to 14

Questions 11 to 14 is given in Figure 7. The analysis of the 8th grade students' answers to the 11-14th questions are given at Table 12. The eleventh question aimed to get students to divide the divisors and to grasp the common ones. In this question, five students selected A, 37 students selected B, two students selected C, one student selected D, and three students preferred not to answer the question. When we turn the data into percentages, 10.4% represent option A, 77.1% represent option B, 77.1% represent option C, 4.2% represent option D, and the percentage of students who did not respond was 6.3%. In this problem, the divisors of the number 2000 were tried to be asked in the form of a problem and the fact that many of the students gave the correct answer indicated that this objective was understood. In the twelfth question, two students marked A, three students marked B, one student marked C, 42 students selected D, and all of the students answered the question. When we convert the data to percentages, students answered option A at

4.2%, option B at 6.3%, option C at 4.2%, and option D at 87.5%. In this question, the students were asked the common multipliers question and most of them answered the question correctly.

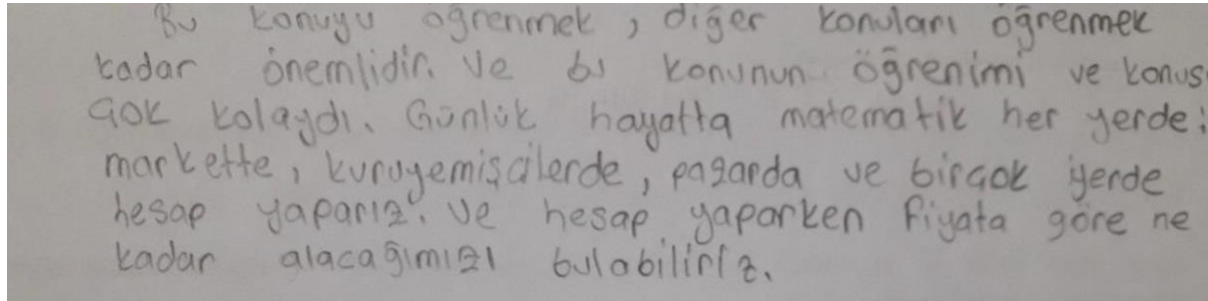
The thirteenth question was aimed at getting students to divide the divisors and to grasp the common ones. In this question, two students marked A, five students marked B, five students marked C, 36 students selected D, and all students answered the question. When we converted the data to a percentage, students answered option A at 4.2%, option B at 10.4%, option C at 10.4%, and option D at 75%. On the answer sheets of the students, the least wrong answer was 1, "The number 1 is the multiplier of each number." This was thought to be due to the question being well understood.

In the fourteenth question, the students were directed to find the divisors of the numbers and to grasp the common ones. In this question, three students marked A, one student marked B, six students marked C, 36 students selected D, and two students preferred not to answer the question. When we convert the data to percentages, students answered option A at 6.3%, option B at 2.1%, option C at 12.5%, and option D at 75%. The percentage of students who did not respond corresponded to 4.2%. This question was asked to find the common divisors of the numbers. Again, most of the students answered the question correctly. It is thought that the correct answer rate was high, because the numbers were small, and these numbers were due to the familiarity of the students.

Table 12. The analysis of the answers given by 8th grade students to questions 11 to 14

Question	Option A	Option B	Option C	Option D	Empty	Right Answer %	SD
11	5	37*	2	1	3	77.08	15.39
12	2	3	1	42*	0	87.5	18.15
13	2	5	5	36*	0	75	14.91
14	3	1	6	36*	2	75	14.88

When the data were analyzed, it was found that both the 6th and 8th grade students generally grasped the factor of multipliers and factorization well. At the end of all questions, the students were asked a question such as, "What are the factors you can relate to this subject in our lives after multiplier and factorization were told by your teacher and how do you think that this affects your attitude and behavior towards mathematics lesson?" A representative sample response is below:

Figure 8. The example response received by the 8th grade middle school students on the multipliers and factorization

Discussion

One hundred fifty-five middle school students participated in this study, which was conducted on learning difficulties and misconceptions of middle school students on the topic of "Multipliers and Factorization". The findings are listed below:

- Students had more difficulty with indirectly asked questions. Student achievement was higher when asked directly about objectives. This is thought to be because students read at a low level and therefore have difficulty in understanding what they read.
- It was seen that the percentage of student achievement was lower for the questions in which distractions were placed.
- When the data were analyzed, it was shown that 6th grade students generally got higher scores than 8th grade students, and that 8th grade students had to have more accumulation of skill to answer questions at their level.
- Similar results were obtained in questions of the same style and logic. This shows that the reliability of the test is high.
- In the study, it was comprehended that the number 1 is a multiplier and that the number itself is both a multiplier and a multiple.

When students were asked an interpretation question about where the multipliers and base were used today, they often said that they were used in markets, shopping, or sharing something. This shows that mathematics is in life. Uysal (2013) stated that mathematics is a necessity, a part of life, and that it appears in many parts of our lives and accelerates social and scientific development.

Suggestions

From the study, several suggestions can be made. These suggestions are listed below:

- When explaining mathematics topics, students should first be asked what they think about that subject and their thoughts should be understood. To do this, a question-answer or pre-test can be applied. This may be one of the most effective methods to understand misconceptions of students. If pretesting is to be carried out, the teacher should identify the questions (s)he will ask well and be predictive of the misconceptions that may occur.

Otherwise, trying to describe new concepts on misconceptions makes the concepts more complex and difficult to understand, which can cause students to deepen their misconceptions.

- Visual materials should be used when explaining multipliers, multiples and factorization. Mathematics courses are already composed of abstract concepts in general. In this case, the subject may not be fully understood, which leads to misconceptions. In short, abstract concepts should be made concrete with visual materials. For example, when asked for the multipliers of 16, teachers can have 16 items (beans, chickpeas, coins, pens, etc.) that they can use in the classroom, and use the visual aids to help make it easier for students to understand. If there is an equal number of objects in each group, then the total number cannot be divided by the number of objects into the group.
- The places where students have learning difficulties and misconceptions that may occur should be envisioned while preparing textbooks, and a separate chapter should be prepared for the books outlining possible misconceptions. For example, when explaining multipliers and multiples, it is also necessary to specify that a multiplier is not multiplying the number, and that the number itself is a multiple when the multiples of the number are taken.
- As in many cases, most of the solutions lie with the teachers, in that the teacher must be competent in the subject and know the students well. In this context, physical conditions of the classes, class facilities, and technological facilities should be appropriate.
- Teachers should give examples from daily life as much as possible. Examples not from experiences will remain in the student's mind, which may lead to further deepening of existing misconceptions or new misconceptions. Giving examples by the teacher in accordance with the conditions of the location in which (s)he is working may make it

easier for the student to understand the subject.

- One of the most common pedagogical errors is always giving the same numbers as examples. This confuses the student when a different number or a negative number is given and alienates the student from the question. For example, although the multiples of the numbers encountered in daily life are easy to find, multiples of the numbers such as 17 and 23 have been given incorrectly by some students, which is thought to be due to the fact that the students are not familiar with the numbers.
- When asking questions, teachers should ask questions that make students think rather than memorize the subject. The teacher should constantly try to get to the bottom of the student's thinking and provide the student with a comfortable environment to ensure that (s)he expresses all aspects of the student's thinking. This provides an understanding of the misconceptions that exist in the student and the teacher can continue to eliminate misconceptions in the student.
- If grades are given, the gain should be explained before the grade. For example, instead of directly saying “1 is the multiplier of all numbers.”, the student should be able to see that 1 is a multiplier in each number, which provides the basis for the student to better understand the subject and not misunderstand the concept.

At the end of the study, it was seen that the questions that the students did incorrectly were caused by lack of knowledge or because they had difficulty in understanding. For this reason, the duty of teachers and parents is to ensure that students read plenty of books.

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