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Research Article / Araştırma Makalesi

Investigating Divided Attention during Mathematics Instruction: A Case Study with 8th Grade Students

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Abstract

This study examined the divided attention patterns of 8th grade students during mathematics instruction and explored how these processes influence their learning performance. The participants consisted of four students (two girls and two boys) selected through criterion sampling based on their mathematics achievement scores. A qualitative case study design was employed, and data were collected through classroom observations, semi-structured interviews and assessment forms implemented during a five-week instructional process structured across five phases. The findings revealed that high-achieving students predominantly exhibited strong selective attention, focusing on instructional stimuli while effectively filtering irrelevant input. In contrast, mid-achieving students demonstrated higher levels of divided attention but had weaker filtering mechanisms, allocating cognitive resources to both relevant and irrelevant stimuli. These results indicate that although divided attention may support the simultaneous processing of multiple inputs, insufficient attention filtering reduces task efficiency and learning performance. The study underscores the importance of achieving an optimal balance between selective and divided attention in instructional design. Creating cognitively structured learning environments and incorporating attention-regulation strategies may help students manage attention more effectively and enhance learning outcomes. These findings contribute to the literature by providing classroom-based evidence on attention regulation among adolescents in exam-oriented mathematics settings.

Keywords: Divided attention, selective attention, cognitive load, middle school mathematics, instructional design

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INTRODUCTION

In contemporary classroom environments, students frequently navigate simultaneous instructional and digital stimuli, which place increasing demands on cognitive processes such as attention, perception, and working memory (Oberauer, 2019; Blain et al., 2022).

In today's rapidly digitalised learning environments, students are frequently exposed to simultaneous instructional and external stimuli, which places increased demands on cognitive processes such as attention, perception and working memory (Oberauer, 2019; Blain et al., 2022). Among these, attention is widely recognised as a prerequisite for learning and a key determinant of academic performance (Anderson, 2010; Posner & Rothbart, 2018).

Attention is a multidimensional process comprising selective, sustained and divided components (Corbetta & Shulman, 2002; Chun et al., 2011). Selective attention allows learners to focus on relevant information while suppressing distractions, whereas divided attention involves managing multiple inputs simultaneously, a skill that has become increasingly salient with the prevalence of multimedia learning environments (Lodge & Groves, 2019; May & Elder, 2018). However, research indicates that divided attention can either support learning—when multiple stimuli are pedagogically aligned—or hinder it by increasing extraneous cognitive load (Murphy & Castel, 2023; Sweller et al., 2019).

In the Turkish education system, attention-related challenges are particularly relevant for 8th grade students due to the high-stakes LGS transition exam. This competitive environment elevates both cognitive and emotional demands, which may disrupt attention regulation. Studies have shown that mathematics exam anxiety and attention difficulties are closely linked to performance (Kaymak Özmen, 2010; Göktepe Yıldız & Göktepe Körpeoğlu, 2020; Sevgi & Çalışkan, 2020). Despite this, most research examining divided attention has focused on university students or laboratory settings (Junco, 2012; Sana et al., 2013), while limited evidence exists on how adolescents manage attention in natural mathematics classrooms (Uncapher et al., 2017; Radesky et al., 2020).

Given the simultaneous visual and auditory demands of mathematics lessons—combined with the exam-oriented structure of 8th grade instruction—there is a clear need to investigate how students regulate attention when required to process multiple stimuli. Addressing this gap, the present study aims to explore how divided attention manifests in authentic classroom conditions.

Accordingly, the research question guiding this study is: "How do 8th grade students experience and demonstrate divided attention during mathematics instruction?"

THEORETICAL FRAMEWORK

This study is grounded in theories of attention and cognitive load, which together provide a foundation for understanding how students manage simultaneous instructional stimuli and how these processes influence mathematical learning.

Attention Theory

Attention is conceptualised as a multidimensional construct involving selective, sustained and divided components (Posner & Rothbart, 2018; Chun, Golomb, & Turk-Browne, 2011). Selective attention enables learners to focus on task-relevant stimuli and suppress distractions, whereas divided attention involves processing more than one input simultaneously. While divided attention may be adaptive when both sources are educationally relevant, it can compete with selective attention and reduce efficiency (Uncapher et al., 2017; Radesky et al., 2020). From an executive function perspective, cognitive shifting—the ability to alternate between auditory and written information—is also crucial during mathematics tasks, which often require integration of multiple representations.

Cognitive Load Theory

According to Cognitive Load Theory (Sweller, van Merriënboer, & Paas, 2019; Kalyuga, 2020), the capacity of working memory is limited, and learning depends on the balance between intrinsic, extraneous and germane loads. When students are exposed to multiple simultaneous stimuli, divided attention may increase extraneous load, leaving fewer resources for processing essential mathematical content. Conversely, reducing irrelevant input and designing instruction in a cognitively streamlined manner facilitates germane processing and enhances learning efficiency.

Applications in Mathematics Education

Mathematics instruction often requires learners to integrate symbolic, visual and verbal information, which places high demands on attention regulation and cognitive resources (Poorghorban, Jabbari, & Chamandar, 2018). Previous research has shown that selective filtering of task-relevant stimuli is a strong predictor of mathematical performance (Robertson

& Schmitter-Edgecombe, 2017; Chen et al., 1996). In this context, students' ability to efficiently shift attention between written and oral input, while suppressing irrelevant stimuli, is essential to minimise cognitive overload and maintain accuracy.

Taken together, these theoretical perspectives indicate that divided attention should not be evaluated in isolation. Instead, its educational impact depends on the interaction with selective attention, cognitive shifting and cognitive load. This integrated framework guided the present study in examining how 8th grade students allocated attention during mathematics lessons and how these attentional processes were associated with their academic performance.

DESIGN AND IMPLEMENTATION OF THE ACTIVITY

Intended Learning Outcomes

The activity was designed in alignment with the 8th-grade mathematics curriculum, specifically addressing the topic of probability, which was selected due to its multimodal instructional nature and high cognitive demand in exam-oriented contexts. The intended learning outcomes were to:

- **a)** enhance students' ability to integrate written and oral information;
- **b)** develop selective and divided attention skills during authentic classroom tasks; and
- **c)** examine how attention management influences task performance.

Materials and Learning Environment

Traditional classroom tools were used, including the blackboard, teacher explanations, students' notebooks and short written assessment forms. In selected phases, short oral anecdotes (e.g., Nasreddin Hodja stories) were intentionally incorporated as external stimuli to examine responses to non-academic distractions. The implementation took place over five consecutive weeks during regular mathematics lessons (each lasting 40 minutes), ensuring ecological validity.

Step-by-Step Implementation

The activity was structured in five sequential instructional phases. The fixed sequence was informed by Cognitive Load Theory, gradually increasing multimodal demand to prevent initial overload and allow systematic observation of attentional shifts:

1. **Phase 1 – Simultaneous written and oral input:** Students copied probability notes while the teacher provided complementary explanations.
2. **Phase 2 – Written-only instruction:** All information was presented on the board with no oral support to promote selective attention.
3. **Phase 3 – Limited oral integration:** One assessment item required recall of oral information, testing students' ability to differentiate relevant verbal input.
4. **Phase 4 – Emphasised oral input:** The teacher used emphatic verbal cues, with one item based solely on oral information.
5. **Phase 5 – Irrelevant verbal stimuli:** Humorous non-academic anecdotes were shared during task completion, allowing examination of external divided attention and extraneous cognitive load.

The order was intentionally preserved to support within-case comparison and ensure consistency in cognitive progression.

Performance Outcomes

Student performance was evaluated separately for each phase. As shown in Table 1, the highest performance was observed in Phase 2 (M = 4.7/5; 94%), where selective attention dominated. Performance declined as oral input increased and was lowest in Phase 5 (M = 0.9/3; 30%), where irrelevant stimuli triggered external attention allocation. These findings indicate that tasks requiring selective attention yield higher efficiency, whereas divided attention particularly toward non-instructional stimuli negatively affects performance.

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Table 1. Phase-Based Student Performance and Dominant Attention Type

Phase	Input Condition	Items	Mean Correct	Performance	Dominant Attention
1	Written + oral	3	2.5	83.3%	Divided
2	Written only	5	4.7	94%	Selective
3	Limited oral	4	3.2	80%	Mixed (selective dominant)
4	Emphasised oral	5	3.4	68%	Divided
5	Irrelevant oral	3	0.9	30%	External divided

The phase-based trend aligns with qualitative observations presented earlier, reinforcing the link between attention regulation and learning efficiency.

Participants and Context

The study was conducted in a public middle school located in Samsun, Turkey, during the 2023–2024 academic year. Four 8th grade students (two girls and two boys, aged 13–14) were selected using criterion sampling based on achieving at least 85 out of 100 in their most recent mathematics exam. This criterion was adopted to ensure adequate academic readiness for cognitively demanding attention-related tasks. In addition to achievement level, gender balance and classroom participation were considered, and teacher evaluations supported the selection process. All students volunteered to participate, and informed consent was obtained from both students and their parents. To preserve confidentiality, pseudonyms (SE, SY, SS, SN) were assigned.

The implementation was conducted during regular mathematics lessons within a natural classroom setting over five consecutive weeks, with each session lasting approximately 40 minutes. Instructional procedures were not modified, which supported ecological validity. The classroom teacher, who also acted as the researcher, facilitated the sessions and conducted systematic observations while maintaining reflective notes to minimise potential researcher bias.

The 8th grade context is particularly significant in Türkiye due to the exam-oriented structure of mathematics instruction and the cognitive and emotional demands associated with the LGS high-stakes transition exam. Although the study involved a limited number of participants, this aligns with the qualitative case study design, which prioritises depth of analysis over statistical generalisation. Future research should consider expanding the participant group to include students with varying achievement levels and socio-economic backgrounds (e.g., 12–20 students) to enhance the transferability of findings and enable comparative analysis.

RESEARCH DESIGN, DATA COLLECTION AND ANALYSIS

Research Design

This study employed a qualitative case study design, which allows for the in-depth examination of a bounded system within its natural classroom environment (Yin, 2018; Stake, 1995; Merriam, 2009). A case study approach was considered particularly appropriate for exploring complex cognitive processes and contextual influences. In this study, the case was defined as the attention processes of 8th grade students during mathematics instruction, examined through multiple data sources, including classroom observations, semi-structured interviews and assessment forms.

As Creswell and Poth (2018) emphasise, the case study design is well suited for answering "how" and "why" questions related to contemporary phenomena over which the researcher has limited direct control. Although the researcher also acted as the classroom teacher, the attention-related behaviours investigated were not intentionally manipulated but naturally observed within authentic instructional conditions. Reflective field notes and triangulation of data sources were used to minimise potential researcher bias and reinforce methodological rigour.

This approach enabled attention to be examined as a dynamic, context-dependent construct rather than as an isolated cognitive variable, aligning with current recommendations in mathematics education research to adopt holistic and classroom-based perspectives (Lesh & Lehrer, 2000; Goldin, 2020). Accordingly, the design facilitated the collection of rich qualitative data that captured both behavioural and cognitive manifestations of students' attention processes during mathematics learning.

Data Collection

Multiple data sources were utilised to ensure triangulation and contextual depth, including weekly assessment forms, semi-structured interviews, and structured classroom observations. The assessment forms were administered over five consecutive weeks and were designed to capture students' recall, comprehension, and transfer of mathematical content under varying attention conditions. Prior to the main implementation, a pilot test was conducted with two non-participant 8th grade students to refine task instructions and timing procedures under authentic classroom conditions.

Semi-structured interviews were conducted following each session to explore students' experiences of attention regulation, perceived sources of distraction, and strategies used to process information. To activate metacognitive awareness, students were also asked briefly before the implementation to identify potential sources of distraction during mathematics lessons.

Structured classroom observations were employed to document behavioural indicators of attention (e.g., note-taking, eye contact, responsiveness to external stimuli). The observation forms were adapted from previous attention-focused studies (e.g., Radesky et al., 2020) and were completed independently by the researcher and a second observer teacher. Inter-rater agreement exceeded 90%, supporting the reliability of observational findings.

All assessment forms were developed by the researcher and reviewed by two subject-matter experts to ensure content validity. Interviews were audio-recorded and transcribed verbatim. Data triangulation was achieved through the integration of observation notes, interview responses, and task-based assessment results.

Although advanced neurophysiological tools (e.g., eye-tracking, EEG) were not employed due to ethical restrictions and to preserve ecological validity, future research may benefit from the inclusion of such methods to obtain real-time evidence of attentional processes.

Data Analysis

The collected data were analysed through qualitative content analysis (Yıldırım & Şimşek, 2018), enabling the systematic identification of recurring attentional patterns. To ensure methodological rigour and interpretive depth, a hybrid coding approach integrating both inductive and deductive reasoning was adopted (Miles & Huberman, 1994; Schreier, 2012). All interview transcripts, observation notes and student responses were transcribed and repeatedly reviewed. Open coding was first conducted line by line to identify meaningful expressions related to attentional behaviours (e.g., maintaining eye contact, writing while listening, reacting to external noise). These codes were examined through analytic memos and grouped during axial coding, which enabled the identification of relationships across selective, divided and distracted attention. Subsequently, selective coding consolidated the categories into four data-driven themes.

Although codes were initially derived inductively, final categorisation was aligned with theoretical constructs from Attention Theory (Posner & Rothbart, 2018; Chun et al., 2011) and Cognitive Load Theory (Sweller et al., 2019). The analytical framework was therefore structured around four main attention types: (1) selective attention, (2) divided attention, (3) sustained attention and (4) orientation toward external stimuli.

To ensure credibility and trustworthiness (Lincoln & Guba, 1985), multiple validation strategies were applied. Data triangulation was achieved by analysing classroom observations, interviews and assessment responses. Expert review was conducted with two specialists in mathematics education and qualitative analysis, and peer debriefing with a cognitive psychology researcher supported theoretical alignment. Two independent coders analysed the dataset, and the inter-rater reliability coefficient using Miles and Huberman’s (1994) formula was 0.87, exceeding the recommended threshold of 0.80. In addition, 20% of the data were re-coded by the researcher after a two-week interval, with internal consistency exceeding 90%.

As the researcher also acted as the classroom teacher, reflexive memos were used to document interpretive decisions and mitigate potential bias. All analytic stages from initial coding to theme refinement were documented in an audit trail to ensure transparency and replicability. These procedures ensured that the analysis accurately captured both individual cognitive responses and the classroom dynamics influencing students' divided attention, supported by theoretical coherence and methodological rigour.

FINDINGS AND DISCUSSION

This section presents the findings regarding students' attention profiles during mathematics instruction. Based on the content analysis, four main themes were identified: *Selective Attention, Divided Attention, Sustained Attention,* and *Orientation Toward External Stimuli*. These themes were derived using a hybrid inductive–deductive coding strategy. The analysis followed three stages open, axial, and selective coding and was theoretically informed by Cognitive Load Theory and established attention frameworks (Posner & Rothbart, 2018; Sweller et al., 2019).

The thematic categorisation was consistently observed across all five instructional phases, which had been systematically structured within the intervention. To ensure contextual clarity and analytical depth, concise extracts from classroom dialogue were presented in Table **2** to illustrate how each attentional pattern naturally manifested during the activity.

Table 2 provides representative excerpts corresponding to the four themes and indicates the instructional phases in which they were predominantly observed.

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Table 2. Sample excerpts and classroom dialogue illustrating students' attention orientations

Student	Phase	Code	Representative Quote (with example dialogue)	Theme
SE	2	Focus on written content	"I followed the notes on the board carefully; I heard the teacher but stayed focused on writing." Example classroom dialogue: Teacher: "You may also consider complementary events while writing." SE (writing): "I'll write what's on the board first."	Selective attention
SY	3	Integration of oral and written input	"The teacher said it, I added it to my notes." Example classroom dialogue: Teacher: "Not all outcomes are equally likely." SY: "Should I note that under the table?"	Divided attention
SS	5	Attending to irrelevant input	"The Nasreddin Hodja story was so funny, I remembered it well." Example classroom dialogue: Teacher (laughing): "Once, Hodja tried to measure the lake with his shoes..." SS (smiling, stops writing): "Really? I've never heard that story!"	Orientation toward external stimuli
SN	3	Attention to oral explanation	"I carefully listened to the teacher's examples." Example classroom dialogue: Teacher: "Imagine pulling two red balls from this bag." SN: "Okay, so is this like dependent events?"	Divided attention

In addition to the qualitative findings, descriptive statistics were used to demonstrate the relationship between attention types and students' performance across instructional phases. As shown in Table 2 and Figure 1, the highest achievement was recorded in Phase 2 (94%), where selective attention was activated through written-only instruction. Performance declined progressively in phases requiring the simultaneous processing of verbal and written input, reflecting increased cognitive load, and reached its lowest level in Phase 5 (30%), during which irrelevant oral stimuli triggered external divided attention. These quantitative results corroborate the thematic analysis by demonstrating that selective attention is associated with higher task efficiency, whereas divided attention particularly when directed toward non-instructional stimuli negatively affects learning performance.

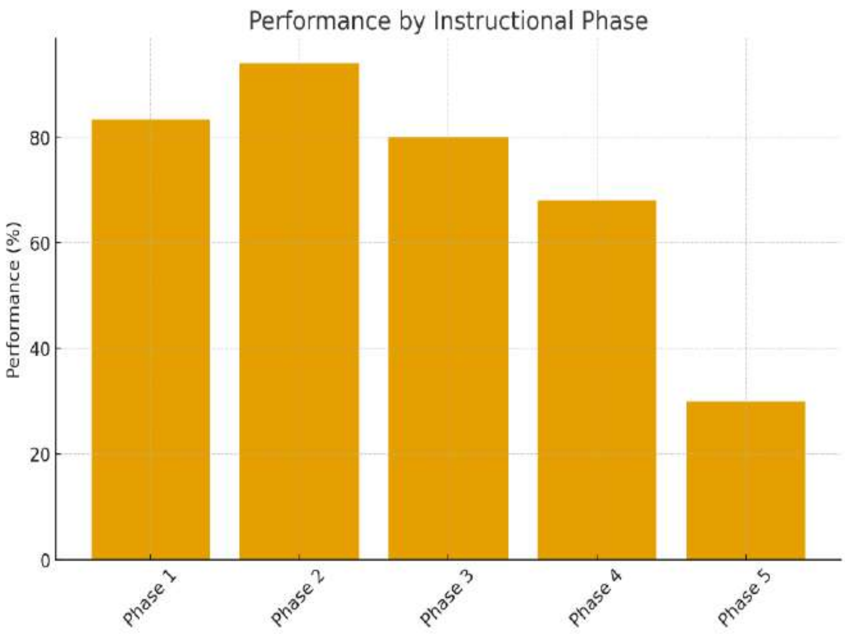

Figure 1. Student performance rates by instructional phase

As shown in Figure 1, student achievement peaked during Phase 2, when selective attention was predominant, and declined progressively across subsequent phases, reaching the lowest level in Phase 5 where external divided attention was triggered.

Table 3. Phase-based student performance and dominant attention type

Phase	Number of Items	Mean Correct Responses	Performance (%)	Dominant Attention Type
Phase 1	3	2.5	83.3%	Divided (Simultaneous written + oral)
Phase 2	**5**	**4.7**	**94%**	**Selective**
Phase 3	4	3.2	80%	Mixed (Selective dominant)
Phase 4	5	3.4	68%	Divided
Phase 5	**3**	**0.9**	**30%**	**External Divided**

As shown in Table 3, students achieved the highest performance in Phase 2 (94%), where only written input was provided and selective attention was predominant. Performance remained relatively high in Phase 1 (83.3%) and Phase 3 (80%), during which students processed both written and limited oral input. A further decrease was observed in Phase 4 (68%), where increased reliance on oral input required greater attentional switching. The lowest performance was recorded in Phase 5 (30%), during which the inclusion of irrelevant oral stimuli redirected attention externally, suggesting that the dominance of external divided attention negatively affected task accuracy. These results indicate that instructional phases that facilitate selective attention are associated with higher learning efficiency, whereas those that trigger divided or externally oriented attention correspond to reduced performance.

This trend is consistent with Cognitive Load Theory, which posits that non-instructional stimuli contribute to extraneous cognitive load and limit the capacity of working memory for task-relevant processing (Sweller et al., 2019). In line with this, Uncapher and Wagner (2018) reported that orientation toward external stimuli may impair sustained engagement, and Roda and Thomas (2006) emphasised the importance of adaptive attention control in multimodal learning environments.

Qualitative observations further supported these results. High-achieving students (SE and SY) were more likely to employ selective attention consistently, focusing on instructional content and filtering irrelevant information, whereas mid-achieving students (SS and SN) exhibited higher levels of divided attention but were less effective at suppressing distracting stimuli. This imbalance appeared to reduce their processing efficiency and contributed to a greater decline in performance when irrelevant input was introduced.

In summary, the findings suggest that the effectiveness of divided attention depends on the ability to selectively prioritise instructional stimuli while inhibiting irrelevant input. These synthesised insights form the basis for the overall conclusions of the study and the recommendations presented in the next section.

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CONCLUSION AND RECOMMENDATIONS

This study examined the divided attention patterns of four 8th grade students during mathematics instruction and demonstrated how these attentional orientations were associated with academic performance. Findings revealed a clear contrast between students: high-achieving students predominantly exhibited selective attention, maintaining focus on instructional stimuli and filtering irrelevant information, whereas mid-achieving students showed higher levels of divided attention with weaker filtering mechanisms, resulting in the allocation of cognitive resources to both relevant and irrelevant stimuli. These results suggest that effective attention management particularly in achieving an optimal balance between selective and divided attention is a key determinant of learning efficiency.

Theoretical Contributions

This study contributes to the existing literature on attention and cognitive load by examining divided attention in a natural middle school mathematics classroom context. Unlike previous research predominantly conducted with university students or in controlled laboratory settings, the findings offer insights into how adolescents manage simultaneous instructional inputs within exam-oriented learning environments. The integrated results indicate that selective attention enhances cognitive efficiency by minimising extraneous load, while divided attention may be adaptive when directed toward task-relevant stimuli. Thus, this study expands the theoretical understanding of how attentional regulation processes influence mathematics learning during adolescence.

Practical Contributions

The findings provide several important implications for instructional design and classroom practice:

- Teachers should create cognitively streamlined and well-structured learning environments, minimising unnecessary distractions while intentionally coordinating multimodal instructional resources.

- Attention-regulation strategies such as guided note-taking, short focus exercises or structured listening activities can help students strengthen selective attention.
- Instructional materials should be clear, goal-oriented and free from irrelevant sensory input to avoid cognitive overload.
- In exam-oriented educational contexts, enhancing students' selective attention skills can enable more efficient processing of simultaneous inputs without exhausting working memory.
- Classroom activities that promote active focus (e.g., mindfulness-based routines or intentional learning tasks) may particularly support students who struggle with attention regulation.

In addition, teacher education programmes should incorporate structured training on attention management and cognitive load reduction, enabling pre-service teachers to design pedagogically efficient mathematics lessons that sustain learner engagement.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future studies should consider expanding the participant sample to include students with diverse academic performance levels and socio-economic backgrounds to enhance the generalisability of findings. Extending the research to other subject areas and incorporating advanced technologies such as eye-tracking or EEG may provide deeper insights into real-time attentional processes. Furthermore, examining the interaction between attention profiles, motivation and technology use could yield a more comprehensive understanding of how adolescents regulate divided attention in contemporary learning environments.

In conclusion, the findings indicate that supporting selective attention while guiding students in effectively managing divided attention is essential for enhancing mathematical learning efficiency. Accordingly, attention regulation should be regarded not merely as a behavioural management technique, but as a core component of pedagogical design.

REFERENCES

Anderson, P. (2010). Assessment and development of executive function (EF) during childhood. Child Neuropsychology, 8(2), 71–82. https://doi.org/10.1076/chin.8.2.71.8724

Barnes, J. J. (2007). The effect of divided attention on memory and learning: Evidence from educational contexts. Journal of Experimental Psychology: Applied, 13(2), 123–134. https://doi.org/10.1037/1076-898X.13.2.123

Blain, S., Hraschina, V., & Bratzke, D. (2022). Shared cognitive resources between memory and attention: Evidence from dual-task auditory paradigms. *Attention, Perception, & Psychophysics*, 84, 2262–2275. https://doi.org/10.3758/s13414-021-02390-2

Chen, H.-C., Schultz, A. B., Ashton-Miller, J. A., Giordani, B., Alexander, N. B., & Guire, K. E. (1996). Stepping over obstacles: Dividing attention impairs performance of old more than young adults. Journal of Gerontology: Medical Sciences, 51A(3), M116–M122. https://doi.org/10.1093/gerona/51A.3.M116

Chun, M. M., Golomb, J. D., & Turk-Browne, N. B. (2011). A taxonomy of external and internal attention. Annual Review of Psychology, 62, 73–101. https://doi.org/10.1146/annurev.psych.093008.100427

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage Publications.

Corbetta, M., & Shulman, G. L. (2002). Control of goal-directed and stimulus-driven attention in the brain. *Nature Reviews Neuroscience*, 3(3), 201-215.

Fiorella, L., & Mayer, R. E. (2023). Learning as a generative activity: Eight learning strategies that promote understanding. Cambridge University Press.

Goldin, G. A. (2020). Understanding learning in mathematics classrooms: Beyond individual cognition. *Educational Studies in Mathematics, 104*(3), 321–340.

Griffiths, M. D. (2004). Coping with divided attention in learning contexts. Educational Psychology, 24(5), 567–580. https://doi.org/10.1080/0144341042000262965

Junco, R. (2012). The relationship between frequency of Facebook use, multitasking, and academic performance. Computers & Education, 58(1), 162–171. https://doi.org/10.1016/j.compedu.2011.08.004

Kalyuga, S. (2020). Cognitive load theory: Science of learning in the classroom. Educational Psychology Review, 32(2), 601–626. https://doi.org/10.1007/s10648-019-09476-4

LabVanced. (2024). Attention tasks in psychology research: Selective, sustained, divided, shifting attention. LabVanced Blog. Retrieved from https://www.labvanced.com/content/research/en/blog/2024-12-attention-tasks-in-psychology-research/

Lesh, R., & Lehrer, R. (2000). Iterative refinement cycles for improving instructional systems design. *Educational Designer, 1*(1), 1–19.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry.* Sage Publications.

Lodge, J. M., & Groves, A. (2019). *The role of attention in learning in the digital age*. Frontiers in Psychology. https://doi.org/10.3389/fpsyg.2019.01348

May, K. E., & Elder, A. D. (2018). Efficient, helpful, or distracting? A literature review of media multitasking in relation to academic performance. *International Journal of Educational Technology in Higher Education, 15*(1), 13. https://doi.org/10.1186/s41239-018-0096-z

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook (2nd ed.). Sage.

Oberauer, K. (2019). Working memory and attention – A conceptual analysis and review. *Journal of Cognition*, 2(1), Article 36. https://doi.org/10.5334/joc.58

Poorghorban, M., Jabbari, M., & Chamandar, F. (2018). The role of executive functions in mathematical performance: An emphasis on attention and shifting. International Journal of Education and Cognitive Psychology, 4(2), 45–60. https://doi.org/10.1080/ijecp.2018.4.2

Posner, M. I., & Rothbart, M. K. (2018). Attention, self–regulation and consciousness. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1754), 20170250. https://doi.org/10.1098/rstb.2017.0250

Radesky, J. S., Kistin, C. J., Zuckerman, B., Nitzberg, K., Gross, J., Kaplan-Sanoff, M., Augustyn, M., & Silverstein, M. (2020). Patterns of mobile device use by caregivers and children during meals in fast food restaurants. Pediatrics, 133(4), e843–e849. https://doi.org/10.1542/peds.2013-3703

Robertson, I. H., & Schmitter-Edgecombe, M. (2017). The importance of attention in cognitive rehabilitation. Journal of the International Neuropsychological Society, 23(9-10), 789–804. https://doi.org/10.1017/S1355617717000659

Roda, C., & Thomas, J. (2006). *Attention aware systems: Theories, applications, and research agenda. Computers in Human Behavior, 22*(4), 557–587.

Sana, F., Weston, T., & Cepeda, N. J. (2013). Laptop multitasking hinders classroom learning for both users and nearby peers. Computers & Education, 62, 24–31. https://doi.org/10.1016/j.compedu.2012.10.003

Stake, R. E. (1995). *The art of case study research*. Sage Publications.

Schreier, M. (2012). *Qualitative content analysis in practice.* Sage Publications.

Sweller, J., van Merriënboer, J. J. G., & Paas, F. (2019). Cognitive architecture and instructional design: 20 years later. Educational Psychology Review, 31(2), 261–292. https://doi.org/10.1007/s10648-019-09465-5

Uncapher, M. R., Lin, L., Rosen, L. D., Kirkorian, H. L., Baron, N. S., Bailey, K., Cantor, J., Strayer, D. L., Parsons, T. D., & Wagner, A. D. (2017). Media multitasking and cognitive, psychological, neural, and learning differences. Pediatrics, 140(Suppl. 2), S62–S66. https://doi.org/10.1542/peds.2016-1758E

Zhang, D., & Zhou, L. (2022). The effects of multitasking on learning performance among middle school students: Evidence from classroom experiments. Journal of Educational Psychology, 114(3), 453–467. https://doi.org/10.1037/edu0000567

Yıldırım, A., & Şimşek, H. (2018). Qualitative research methods in the social sciences (11th ed.). Seçkin Publishing.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

APPENDICES

Appendix 1: Worksheets from Phase 1

Items to be Written on the Board:

Identifying Possible Outcomes

◆ ***Let's Learn This***

In a probability experiment, each possible result is called an outcome.
The situations we want to occur in an experiment are called events.
The set of all outcomes of an experiment is called the sample space.
The mathematical value representing the occurrence or non-occurrence of an event is called the probability of the event.

● ***Let's Do It Together 2***

Let's examine the concepts of outcome, event, sample space, and probability through the experiment of tossing a die.

In the probability experiment of tossing a die, the outcomes are when the top face shows 1, 2, 3, 4, 5, or 6.
In the same experiment, getting an even number or a number greater than 2 on the top face is an event.

The sample space of this experiment consists of the six possible outcomes: 1, 2, 3, 4, 5, and 6. Probability is the likelihood that a desired event will occur in the experiment of tossing a die.

◆ *Let's Learn This*

When the number of possible outcomes of events are equal, these events are called equally likely events.

If the number of possible outcomes of two different events is greater or smaller than the other, this situation is expressed as more likely or less likely events.

Let's Do It Together 6

There are 20 students in a class, and 10 of them are girls. Let's examine the probability that a randomly selected student from this class is a girl or a boy.

Out of 20 students in the class, 10 are girls and 10 are boys.
Since the number of girls and boys in the class is equal, the probability that a randomly selected student is a girl or a boy is equal.

Sentences to Be Expressed Orally:

1) Impossible event: an event that cannot occur as a result of an experiment.

The probability of an impossible event is "0".

Example: The probability of drawing a white ball from a bag that contains only blue and red balls.

2) Certain event: if an event is sure to occur, it is called a certain event.

The probability of a certain event is "1".

Example: The probability of drawing a blue ball from a bag that contains 5 blue balls.

The probability of an event cannot be greater than 1.

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Appendix 2: Phase 1 Evaluation Exam

End-of-Lesson Test

Assessment and Evaluation:

Answer the following questions.

1) Equal-sized balls numbered from 1 to 20 are placed in a box. Examine the probability that a randomly selected ball has a prime number versus a non-prime number.
To make the probabilities of drawing a ball with a prime number and a non-prime number equal, how many of which balls should be removed from the box?

2) Bekir will choose one clock randomly among 4 broken and 6 working wall clocks in a box. Compare the probabilities of Bekir choosing a broken or working clock.

3) In a bag, there are blue and red balls that have the same properties except for their colors.

Which of the following cannot be the probability of randomly drawing a red ball from the bag?

A) $\frac{1}{2}$ **B)** $\frac{3}{2}$ **C)** $\frac{1}{3}$ **D)** $\frac{4}{3}$

4) Which of the following cannot be the probability of an event?

A) 0 **B)** $\frac{1}{7}$ **C) 1** **D)** $\frac{4}{3}$

5) There are 3 blue, 4 pink, and 5 red pencils in a box.
How can the probability of randomly selecting a green pencil from the box be expressed?

6) There are 5 square and 6 circle-shaped erasers in a box.
How can the probability of randomly selecting an eraser that is square or circle-shaped be expressed?

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Appendix 3: Phase 2 Worksheets

Information Written on the Board

INFORMATION

An expression that contains at least one variable and includes an operation is called an algebraic expression.

Each letter in an algebraic expression represents a number and these letters can take different numerical values. Therefore, the letters in algebraic expressions are called variables (unknowns).

Each part of an algebraic expression separated by addition or subtraction is called a term.

The numbers other than variables in each term are called coefficients.

Let's write the terms, variables, coefficients, and constant terms of the following algebraic expressions in a table.

a) $3a + 5b$ **b)** $-4y^2$ **c)** $21m^2 \cdot n$ **ç)** $2x^2 - 3x + 5$

Algebraic Expressions	**Term(s)**	**Variable(s)**	**Coefficient(s)**	**Constant Term**
$3a + 5b$	$3a$, $5b$	a, b	3, 5	0
$-4y^2$	$-4y^2$	y	-4	0
$21m^2 \cdot n$	$21m^2 \cdot n$	m, n	21	0
$2x^2 - 3x + 5$	$2x^2$, $-3x$, 5	x	2, -3, 5	5

INFORMATION

The term in an algebraic expression that does not contain a variable is called a constant term. Every constant term is also a coefficient.

1. Write the **terms**, **variables**, **coefficients**, and **constant terms** of the algebraic expressions in the table below.

Algebraic Expressions	Term(s)	Variable(s)	Coefficient(s)	Constant Term
3a				
$x^2 \cdot y + x \cdot y$				
$5m - m^2 + 15$				

2. "The length of a rectangular school garden is 23 m longer than its width."

Using this information, find the **algebraic expressions** representing the **width**, **length**, and **perimeter** of the school garden.

3. Match the given algebraic expressions with their different forms.

Find the algebraic expression **that cannot be matched.**

- $8 \cdot x \cdot y \cdot y$
- $5 \cdot a \cdot b \cdot b$
- $-9 \cdot x \cdot y^2 \cdot y$
- $14 \cdot a^2 \cdot b \cdot b$

- $5ab^2$
- $6a^2b^2 + 8a^2b^2$
- $2xy \cdot 4y$

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Appendix 4: Phase 2 Evaluation Worksheets

Assessment and Evaluation

1. Write the terms, variables, coefficients, and constant terms of the algebraic expressions in the table below.

Algebraic Expressions	**Term(s)**	**Variable(s)**	**Coefficient(s)**	**Constant Term**
$3a$				
$x^2 \cdot y + x \cdot y$				
$5m - m^2 + 15$				

2. "The length of a rectangular school garden is 23 m longer than its width."

Using this information, find the algebraic expressions representing the width, length, and perimeter of the school garden.

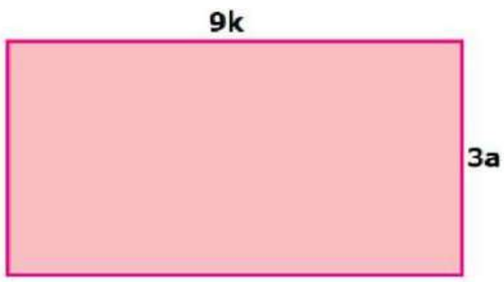
3. Match the given algebraic expressions with their different forms.

Find the algebraic expression **that cannot be matched.**

$8 \cdot x \cdot y \cdot y$ $5 \cdot a \cdot b \cdot b$ $-9 \cdot x \cdot y^2 \cdot y$ $14 \cdot a^2 \cdot b \cdot b$

$5ab^2$ $6a^2b^2 + 8a^2b^2$ $2xy \cdot 4y$

4. The dimensions of the land bought by **Ferhat** are shown in the figure.
Mehmet wants to buy a piece of land that has the **same area** as Ferhat's land.
Draw **two different models** of land that Mehmet can buy.



5.Which of the following is **not equivalent** to the algebraic expression $\mathbf{30x^3y^2}$?

A) $6x^3 \cdot 5y^2$ B) $30x^2 \cdot y^2 \cdot x$ C) $3 \cdot x^3 \cdot 10y^2$ D) $2x^2 \cdot 15y^3$

Question-1

According to the algebraic expression $\mathbf{x^2 + 3xy - x + 2y^2 - 4}$, find the following:

Terms:
Constant term:
Variables:
Coefficients:

Question-2

Find the **number of terms** in the simplest form of the algebraic expression $\mathbf{3y - 5x + 1 + x - 1}$.

Question-3

Find the **sum of the coefficients** in the simplest equivalent form of the algebraic expression $\mathbf{7x - (8x + 2) - x}$.

Question-4

In the algebraic expression of the form $\mathbf{3x + y + m}$, if the **sum of the coefficients** is **–1**, what is the **constant term**?

Question-5

Express the following algebraic expressions in different forms.

$-6x \cdot x =$
$-4 \cdot 3x =$
$y + y + y =$

$y + y + x =$

$a \cdot a \cdot a =$

$3 \cdot x \cdot y =$

Question-6

Express the following algebraic expressions in different forms.

$4x =$

$x^4 =$

$8x^2 =$

$12x =$

$10xy =$

$xy^2 =$

$4a + 3b =$

Question-7

The **length** of a rectangle is **4 times** its **width**.
According to this information, express the following **algebraically**.

Width:
Length:
Area:
Perimeter:

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Appendix 5: Phase 3 Worksheets

Lesson 3 – Items to Be Written on the Board

🔑 KEY INFORMATION

Terms that have the **same variables** and the **same powers of those variables** are called **like terms**.

Like terms can be added or subtracted by factoring out the **common factor** in parentheses.

Example 2:

Match the like terms among the given terms below.
$5x$, $4y^2$, $2y$, x , y^2 , $3xy$

Example 3:

Let's simplify the expression $\mathbf{3(2a + 3b) - 8 + 2b}$ and find the **sum of its coefficients**.

Example 4:

If the **sum of the coefficients** in the expression $\mathbf{7x^2 - 3xy + m}$ is **1**, what is the value of **m**?

Information to Be Expressed Orally:

- If an equality holds true for one or several real number values, such equalities are called *equations*.
- If an equality holds true for all real numbers assigned to its variables, such equalities are called *identities*.
- In short, if after simplification the terms on both sides are exactly the same, the equality is an *identity*.
- 🔹 When an equality is true **for some values** of the unknown (**variable**), it is called an **"equation."**
- ❗ The **solution set** consists of **some real numbers**.
- 🔹 When an equality is true **for all values** of the unknown (**variable**), it is called an **identity.**
- ❗ The **solution set** consists of **all real numbers**.

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Appendix 6: Phase 3 Evaluation Exam

Assessment and Evaluation:

◆ **Match the like terms among the given terms below.**

• $5xy$ • $-6a^2b$ • $-4y$ • $-xy$ • $-3ab^2$ • $6y$
• $-a^2$ • $-3b^2$

◆ **Find the results of the following addition and subtraction operations.**

💜 $3x + 10x =$

💜 $11a + 17a =$

💜 $13b - 20b =$

💜 $(12a + 23b) - (22a - 7b) =$

💜 $(5x - 6y) - (13x - 10y) =$

💜 $a + 2a - 7a - 4a =$

💜 $4x + 7x - 20x =$

💜 $8xy + 13xy - 29xy =$

💜 $x + x + x + x =$

💜 $3x + 4y =$

💜 $2a^2 + a^3 =$

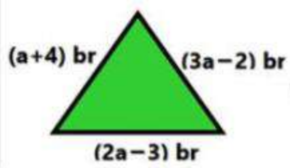
💜 $2x + 3y + 3x + 2y =$

💜 $(-5x + 6y) + (3x - 2y) =$

◆ **Match the like terms among the algebraic expressions below.**

$3a^2$	$5b^2$
$21x^3$	$21xy^2$
$32xy^2$	$71x^2$
$-12x^2$	$-90x^3$
$8b^2$	$8a^2$

- **Calculate the perimeter of the geometric shapes below.**



Perimeter = ?

Appendix 7: Phase 4 Worksheets

In this lesson, problems related to the topic of probability were solved. While students copied the questions and solutions from the board into their notebooks, the teacher orally explained the definition of conditional probability and provided an example.

Information not written on the board but expressed orally:

Conditional Probability

If two events are dependent on each other and the occurrence of one affects the probability of the other, this is called conditional probability. For example, the occurrence of rain depends on the level of humidity in the air. In this case, rainfall is an example of conditional probability.

Appendix 8: Phase 4 Evaluation Exam

QUESTIONS	SOLUTIONS
Question 1: There are 3 red, 4 pink, and 5 purple marbles in a bag. How many more pink marbles should be added to the bag so that the probability of randomly drawing a pink marble becomes 1/2?	
Question 2: In a class with 15 girls and 10 boys, the class president will be chosen by drawing lots. What is the probability (in percentage) that the class president will be a girl?	
Question 3: There are white and yellow eggs in a basket. The probability of randomly drawing a white egg from the basket is 3/5. If there are 18 yellow eggs in the basket, what is the total number of eggs in the basket?	
Question 4: The probability of randomly selecting a story book from a bookshelf is 30%. If there are 12 story books on the shelf, what is the total number of books in the bookshelf?	
Question 5: In a class, there are 12 girls and 13 boys. How many boys must leave the class so that the probability of randomly selecting a girl becomes 3/5?	

SUCCESS..

Appendix 9: Phase 5 Evaluation Exam

QUESTIONS

1. Where was **Nasreddin Hodja** born?
2. Write **two Nasreddin Hodja anecdotes** that were told in class.
3. Write about **your teacher Ayşe's memory related to Nasreddin Hodja** during the summer vacation.

Ethical Approval

Not applicable.

The study was conducted in compliance with ethical research principles. Informed consent was obtained from both students and their parents prior to participation. All participants were assured of confidentiality and their right to withdraw at any stage.

Funding

Not applicable.

Conflict of Interest

None declared.