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Digital Charting and Outlining Note-taking Types on Memory Retention: A Within-Subjects Experimental Study Among University Students

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Abstract

Purpose: This study examined whether digital charting and outlining note-taking methods differ in their effects on immediate memory retention among undergraduate psychology students at Universitas Padjadjaran.

Research Methodology: A within-subjects experimental design involved 108 psychology students from the 2022 and 2023 cohorts. Participants completed two note taking conditions charting and outlining presented online via Zoom for seven minutes each. Immediate memory retention was measured using separate 10 item multiple choice quizzes administered through Google Forms. Data were analyzed using the Kruskal Wallis test due to non normal distribution.

Results: No significant difference was found between charting and outlining note taking methods in immediate memory retention ($p > .05$). Both conditions produced high levels of accuracy, with mean scores of 84.8% for charting and 80.6% for outlining. Variations in performance were observed across individual items, suggesting differences in item difficulty rather than note taking format effects.

Conclusions: Digital charting and outlining methods showed equivalent effectiveness in supporting short term memory retention when learning duration and content exposure were controlled.

Limitations: Findings were limited by online implementation, non equivalent learning materials, the absence of a control group, and uncontrolled individual factors such as attention and motivation.

Contributions: This study provides evidence on digital note taking practices in Indonesian higher education and offers guidance for students selecting note-taking strategies in online learning environments.

Keywords: *Charting, Digital Learning, Memory Retention, Note Taking, Outlining.*

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1. Introduction

Higher education constitutes a cognitively demanding environment in which students must process, organize, and retain substantial volumes of complex information across diverse academic disciplines. The transition to university-level study intensifies this demand: students encounter unfamiliar content at higher density, greater conceptual abstraction, and faster presentation rates than they have previously experienced (Bonner & Holliday, 2006). Within this context, note-taking has emerged as one of the most widely practiced academic learning strategies: the activity of selectively recording, organizing, and structuring lecture or textual content functions both as an encoding aid during learning and as a retrieval cue during subsequent review (Ward, & Tatsukawa, 2003; Stefanou, Hoffman, & Vielee, 2007).

Note-taking produces documented benefits for memory retention through two primary mechanisms. The encoding function of note-taking holds that the act of selecting and writing information promotes deeper cognitive processing during the learning episode, strengthening memory traces relative to passive listening or reading (Piolat, Olive, & Kellogg, 2005; Mueller, & Oppenheimer, 2014). The external storage function holds that written notes provide a retrievable record that supports review and spaced recall, compensating for the natural decay of lecture-based memory over time (Ward and Tatsukawa, 2003; Shiffrin, & Atkinson, 1969). Both functions are theoretically relevant to university learning, where both in-session comprehension and long-term retention matter for academic performance.

Note-taking can be performed in multiple organizational formats, each imposing distinct cognitive demands and producing distinct structural outputs. Among the formats most commonly used by university students are outlining (hierarchical representation of main ideas and supporting points using indentation and bullet structures), charting (tabular organization of information across categories and attributes), mind mapping (radial spatial organization), and the Cornell method (a two-column format separating notes from cues and summary) (Bonner and Holliday, 2006; Moshleh, & Baba, 2013). These formats differ in the cognitive operations they require: outlining supports sequential, hierarchical encoding; charting supports comparative, categorical encoding; and more elaborate formats such as mind mapping support associative, networked encoding (Piolat et al., 2005).

The proliferation of digital learning environments accelerated substantially by the COVID-19 pandemic and the widespread adoption of Zoom, Google Classroom, and Learning Management Systems in Indonesian higher education has shifted note-taking from pen-and-paper to laptop and tablet-based formats. Digital note-taking introduces both new affordances (copy-paste, templates, real-time formatting) and new challenges (distraction susceptibility, reduced kinesthetic encoding) relative to handwritten note-taking (Mueller & Oppenheimer, 2014). The question of which digital note-taking format most effectively supports memory retention is therefore practically significant for the rapidly growing population of Indonesian university students engaged in online learning.

Prior surveys of note-taking format preferences among Indonesian university students indicate a strong preference for outlining: a preliminary assessment conducted for the present study found that 87.5% of psychology students at Universitas Padjadjaran used outlining, while only 7.5% used charting and 5% used other formats. This distributional preference is consistent with Sukma (2020) finding that outlining was the most frequently used and preferred strategy among Indonesian students in listening and learning tasks, attributed to its facilitation of comprehension and quiz performance. However, the theoretical and empirical literature offers reasons to expect that charting may be comparably effective for certain types of content: charting's tabular organization is particularly well-suited to materials that involve comparison across multiple attributes or dimensions, which is a common structure in psychology course content (Moshleh & Baba, 2013).

Despite the practical importance of this question for Indonesian students operating in digital learning environments, no experimental study has directly compared the effects of digital charting and outlining note-taking on memory retention using a within-subjects design with equivalent testing procedures. This study addresses this gap by administering both charting and outlining note-taking

conditions to the same participants and comparing immediate memory retention scores on matched 10-item multiple-choice quizzes. The research hypothesis is that there will be a statistically significant difference between digital charting and outlining note-taking conditions in their effects on memory retention.

2. Literature Review and Hypotheses Development

2.1 Memory Retention and the Atkinson-Shiffrin Model

Memory is defined as the cognitive system enabling the encoding, storage, and retrieval of information, constituting a fundamental competency for learning and the preservation of individual identity (Strange, Wade, & Hayne, 2008; Chaplin, 2002). The Atkinson-Shiffrin modal model Shiffrin and Atkinson (1969) describes memory as a multi-store architecture comprising three sequential stages. Sensory memory briefly holds incoming perceptual information for a fraction of a second. Short-term memory (working memory) maintains a limited quantity of information in an active, accessible state for approximately 15–30 seconds; information is maintained here through rehearsal. Long-term memory provides a theoretically unlimited and durable repository for information that has undergone sufficient encoding through rehearsal or elaborative processing.

For the present study, the memory processes engaged during note-taking operate as follows: when participants view note-taking materials, sensory registration of the written and visual content initiates processing in sensory memory. Directed attention and active reading during the seven-minute stimulus period transfer information to short-term memory and initiate encoding through the rehearsal of reading. The structured format of the notes whether charting or outlining modulates the depth and organization of this encoding: well organized, categorically coherent notes facilitate schema-based encoding that strengthens long-term memory traces. The immediate memory quiz (administered after the stimulus period without intervening review) assesses the quality of encoding achieved during the seven minute exposure, targeting a combination of short-term and recently encoded long-term memory.

2.2 Note-Taking Methods: Charting and Outlining

Outlining is a hierarchical note-taking format in which main ideas are represented at the highest indentation level, with subordinate details organized beneath them in a nested structure using bullets, numbers, or dashes. Moshleh and Baba (2013) identify outlining's key advantages as its support for well-organized information representation, its reduction of redundancy through selective point capture, and its facilitation of review through the conversion of main points into questions. Stefanou et al. (2007) characterize outlining as a form of generative learning because the selective organization process requires active cognitive engagement with content structure rather than verbatim transcription. Mueller and Oppenheimer (2014) demonstrated that outlining note-taking promotes deeper conceptual encoding relative to verbatim transcription, producing superior retention of higher-order ideas.

Charting is a tabular note-taking format in which information is organized into rows and columns representing categories, attributes, or comparison dimensions. Charting is particularly effective for content that involves multiple entities sharing common attributes such as psychological theories, developmental stages, or diagnostic criteria because its two dimensional organizational structure makes categorical comparisons visually explicit (Bonner & Holliday, 2006). The cognitive demand of charting involves both selecting which information belongs in which cell (organizational processing) and comparing across rows and columns (relational processing). These demands may either enhance encoding through elaborative comparison or create greater cognitive load than outlining, depending on the complexity of the content being charted.

The differential memory advantages of outlining and charting are theoretically expected to depend on content type: outlining should produce superior encoding for sequentially structured content (such as narrative developmental processes), while charting should produce superior encoding for categorically structured comparative content (such as attribute comparisons across theoretical frameworks). The materials used in the present study adulthood development for charting and Kohlberg moral

development for outlining were selected with this principle in mind, though the consequent non-equivalence of content across conditions is acknowledged as a methodological limitation.

2.3 Note-Taking in Digital Environments

The transition from handwritten to digital note-taking introduces several theoretically significant changes to the note-taking process. Mueller and Oppenheimer (2014) demonstrated that laptop note-taking was associated with greater verbatim transcription and reduced conceptual processing relative to longhand, particularly for lecture content (Crumb, Hildebrandt, & Sutton, 2022; Huang, Jeng, & Lai, 2021). Digital tools that enable rapid text entry may paradoxically reduce encoding depth by decreasing the selectivity and organizational effort that characterize effective note-taking. However, digital formats also offer structural advantages: templates for charting and outlining reduce the cognitive effort required for organizational setup, potentially freeing cognitive resources for content processing (Costley & Fanguy, 2021).

The present study's delivery of note-taking stimuli via Zoom Meeting participants viewed pre-formatted notes on screen rather than actively constructing their own notes is an important design choice that distinguishes this study from most prior note-taking research, in which participants generate their own notes during lecture exposure. In the present paradigm, participants are exposed to completed charting and outlining notes and asked to study and remember them; the variable of interest is therefore the format-driven memory benefit of organized note presentation rather than the encoding benefit of active note construction. This is theoretically relevant to the common student practice of reviewing shared course notes or instructor-provided note skeletons (Ponce, Mayer, & Méndez, 2022; Ruiz, Myers, Morano, & Barry, 2023).

2.4 Individual Difference Variables

Research consistently identifies several individual difference variables that moderate the relationship between note taking format and memory retention. Learning style characterized by preferred sensory modalities (visual, auditory, kinesthetic) or preferred processing modes (deep vs. surface) is proposed to interact with note-taking format effectiveness (Aprilia, Oktaria, Oktafany, & Sari, 2019). Visual learners may benefit disproportionately from charting's spatial organization of information, while verbal learners may prefer the sequential structure of outlining. Motivation students' goal orientation and engagement with learning tasks is documented to affect attention allocation during learning episodes, directly influencing the depth of encoding (Yulianti, Siregar, & Hidayat, 2022). Cognitive capacity differences in working memory span and processing speed determine how much information can be actively processed during a fixed time window, directly affecting both note study and quiz performance (Darouich, Kaddari, Elachqar, & Hlima, 2017).

2.5 Prior Empirical Studies

Table 1 summarizes prior studies on note-taking methods and memory or learning outcomes relevant to the present research.

Table 1. Summary of Prior Studies on Note-taking Methods and Memory/Learning Outcomes

Author(s) & Year	Population / Setting	Method	Key Finding on Note-taking and Memory/Learning Outcomes
Piolat et al. (2005)	University students	Experimental cognitive load	Note-taking is cognitively demanding, consuming attentional resources; the cognitive effort of encoding vs. storage functions differs by note-taking method; linear methods impose lower cognitive load than complex organizational schemes
Bonner and Holliday (2006)	College science students	Observational survey	Students who actively encode and organize information during note-taking achieve higher content retention; strategic note-taking is associated with improved quiz performance across science topics

Author(s) & Year	Population / Setting	Method	Key Finding on Note-taking and Memory/Learning Outcomes
Stefanou et al. (2007)	College students	Quasi-experimental	Note-taking is evidence of generative learning; active organization of lecture content during note-taking enhances long-term retention via deep encoding mechanisms
Ward and Tatsukawa (2003)	Classroom users	System design and evaluation	Note-taking facilitates concept review and retrieval; the organizational structure of notes affects the ease and accuracy of later information retrieval
Mueller and Oppenheimer (2014)	University students	True experiment	Outlining/longhand note-taking promotes deeper conceptual encoding vs. verbatim transcription; selective processing in outlining enhances retention of higher-order information
Sukma (2020)	EFL students, Indonesia	Qualitative interview	Outlining was the most frequently used and preferred note-taking strategy; students reported outlining facilitated easier comprehension and quiz answering compared to other strategies
Aprilia (2017)	Medical students, Universitas Lampung	Correlational	Note-taking practice significantly correlated with quiz performance in endocrine-metabolic lectures; note-taking type and individual learning style are significant moderating variables
Moshleh and Baba (2013)	ESL/EFL learners	Comparative review	Outlining offers structured information organization and facilitates review; its main-point-to-question conversion feature supports active recall

As Table 1 demonstrates, prior research establishes that note-taking generally facilitates memory through encoding and storage mechanisms, and that active organization during note-taking promotes deeper processing. However, direct experimental comparisons of charting versus outlining on memory retention in digital delivery contexts are absent from the published literature, constituting the specific gap addressed by the present study.

2.6 Research Hypothesis

H_0 (Research Hypothesis): There is a statistically significant difference between digital charting and outlining note-taking conditions in their effects on immediate memory retention among psychology students at Universitas Padjadjaran.

H_1 (Null Hypothesis): There is no statistically significant difference between digital charting and outlining note-taking conditions in their effects on immediate memory retention.

3. Research Methodology

3.1 Research Design

A within-subjects (repeated measures) experimental design was employed, in which every participant was exposed to both the charting and outlining note-taking conditions. The within-subjects design was selected to maximize statistical power and enable direct comparison of the same individuals' performance across conditions, eliminating between-subject variability as a source of error (Field, 2018). The design's primary limitation carry over effects, in which the first condition affects performance on the second is acknowledged; because all participants received charting before outlining, any order-related carry-over effects (such as warm-up or familiarity with the testing format) could confound the comparison between conditions.

3.2 Participants

The study sample comprised 108 undergraduate psychology students from the 2022 and 2023 cohorts at the Faculty of Psychology, Universitas Padjadjaran, Bandung, Indonesia. Participants were recruited through purposive sampling targeting students with experience of university-level lectures in developmental psychology (the topic domain of both stimulus materials). The sample was restricted to psychology faculty students to enable use of psychology course content as stimulus material and to ensure participant familiarity with the academic topics presented. All participants provided informed consent prior to data collection.

The use of purposive sampling was considered appropriate because the study required participants who possessed specific academic characteristics relevant to the research objectives. Purposive sampling enables researchers to deliberately select individuals who have the knowledge, experiences, or attributes necessary to provide meaningful responses to the investigated phenomenon (Andrade, 2021). In the present study, psychology students who had been exposed to developmental psychology coursework were expected to have sufficient familiarity with the concepts presented in the note-taking materials, thereby reducing potential comprehension barriers unrelated to the experimental manipulation.

The selection of undergraduate psychology students is also consistent with common practice in educational and psychological research, where student samples are frequently used to investigate learning processes, academic behaviors, and cognitive outcomes in higher education settings (Beanland, Walsh, & Pammer, 2020; Valdez, & Lovell, 2022). Furthermore, adherence to informed consent procedures ensured that participation was voluntary and ethically conducted, in accordance with established standards for research involving human participants in educational and behavioral sciences (Flynn & Bordieri, 2023).

3.3 Stimulus Materials

Two note-taking materials were developed as experimental stimuli. The charting format stimulus presented a comparative table of adulthood development stages, organizing information across developmental periods (early, middle, late adulthood) and multiple attribute dimensions (physical changes, cognitive changes, social roles). The outlining format stimulus presented Kohlberg stages of moral development in a hierarchical bullet-point structure, organizing information from preconventional through postconventional levels with sub-points elaborating each stage's characteristics. Both stimuli were designed to contain approximately equivalent information density and were presented at the same duration (seven minutes) to equate exposure time across conditions. It is important to note that the two stimulus materials address distinct psychological topics, introducing content difficulty as a potential confound in the comparison of memory scores between conditions.

The selection of charting and outlining formats was based on their capacity to organize information in distinct ways that may support learning and memory processes. Charting formats facilitate the comparison of concepts across multiple dimensions by presenting information in a structured matrix, whereas outlining formats emphasize hierarchical relationships and conceptual organization through sequential levels and subcategories (Aiken, Caballero, Douglas, & Lewandowski, 2020; Fiorella, & Mayer, 2021). Such organizational structures can enhance comprehension by reducing cognitive load and helping learners identify relationships among key concepts.

Although efforts were made to standardize information density and exposure duration, the use of different content topics across conditions represents a methodological limitation. Educational research has shown that prior knowledge, topic complexity, and content familiarity can influence learning outcomes independently of instructional format (Kalyuga, 2021; Chen, Kalyuga, & Sweller, 2023). Consequently, differences in memory performance may partially reflect variations in topic difficulty rather than the effects of note-taking format alone. Future studies should consider using identical content presented in multiple note-taking formats to improve internal validity and isolate format-specific effects.

3.4 Procedure

Data collection was conducted online via Zoom Meeting and Google Forms. The session proceeded as follows. In the charting condition: (1) participants received an explanation of the charting note-taking format; (2) the charting stimulus material (adulthood development) was displayed via Zoom screen-share for seven minutes; (3) the charting stimulus was removed and participants immediately completed a 10-item multiple-choice quiz (three response options per item) via Google Forms within five minutes. In the outlining condition, conducted immediately after the charting condition in the same session: (4) participants received an explanation of the outlining note-taking format; (5) the outlining stimulus material (Kohlberg moral development) was displayed via Zoom screen-share for seven minutes; (6) the outlining stimulus was removed and participants completed a 10-item multiple-choice outlining quiz via Google Forms within five minutes. Participants were instructed to attend fully to each stimulus material and to retain it without written notes during the quiz. The use of online platforms for stimulus presentation and assessment is consistent with contemporary educational and psychological research practices that increasingly employ virtual environments for controlled data collection (Archibald, Ambagtsheer, Casey, & Lawless, 2021; Lobe, Morgan, & Hoffman, 2022).

The procedure was designed to measure immediate memory retention by minimizing the delay between stimulus exposure and testing. Immediate recall assessments are frequently used in cognitive psychology because they capture information retained in short-term and working memory before substantial forgetting occur. The equal exposure duration and identical testing time limits across conditions were intended to control procedural factors that might otherwise influence performance.

A limitation of the procedure is that all participants completed the charting condition before the outlining condition, creating the possibility of order effects. Repeated exposure to testing situations may influence subsequent performance through practice, fatigue, or carryover effects, thereby affecting the internal validity of within-subjects designs (Lakens, 2022). Future research could employ counterbalanced presentation orders or randomized condition sequences to reduce these potential biases and strengthen causal inference regarding note-taking format effects.

3.5 Memory Retention Measurement

Memory retention was operationalized as the number of correct responses out of 10 items on each multiple choice quiz. Items assessed factual recall of specific content from the stimulus notes (e.g., characteristics of specific developmental stages; features of specific moral reasoning levels). Both quizzes were developed specifically for this study. While the quizzes were content-appropriate, formal psychometric validation (item analysis, reliability estimation) was not conducted prior to administration, representing a measurement quality limitation.

The use of multiple choice assessments is common in memory and educational research because they provide an efficient and objective means of measuring factual knowledge retention and recall performance (Gurung & Stoa, 2020). By employing identical response formats and equal numbers of items across conditions, the present study sought to maintain consistency in measurement and minimize potential scoring bias between the charting and outlining note-taking conditions.

Nevertheless, the absence of formal psychometric evaluation limits confidence in the precision and consistency of the measurement instrument. Educational measurement literature emphasizes that evidence of reliability and item quality is essential to ensure that observed scores accurately reflect the intended construct rather than measurement error (McCoach, Gable, & Madura, 2023; Wiberg, Bränberg, & Molenaar, 2024). Consequently, the findings should be interpreted cautiously, and future studies are encouraged to conduct item analysis, reliability testing, and validation procedures before data collection to strengthen the robustness of memory retention measurement.

3.6 Data Analysis

Descriptive statistics (mean correct scores per item, overall mean correct rates) were computed for both conditions. Normality of the score distributions was assessed using the Kolmogorov-Smirnov test. Due to non-normal distribution in the charting data ($p < .05$), non-parametric analysis was

applied to both conditions for consistency. The Kruskal-Wallis test was conducted to examine whether memory retention scores differed significantly across the two cohort groups within each note-taking condition (decision criterion: reject H_1 if $p \leq \alpha = .05$). Between-condition comparison of overall memory accuracy rates was examined descriptively. All analyses were performed using IBM SPSS Statistics version 22.

To provide a more comprehensive interpretation of the findings, future studies may consider incorporating effect size measures and confidence intervals alongside significance testing. These additional statistics can help determine the practical magnitude of observed differences, particularly in cases where statistical significance is not achieved. Reporting effect sizes would also facilitate comparisons across studies investigating digital note-taking methods and contribute to a more nuanced understanding of the relationship between note-taking format and memory retention.

4. Results and Discussions

4.1 Descriptive Statistics: Item-Level Memory Performance

Table 2. Item-Level Memory Retention Performance: Charting vs. Outlining Conditions (n = 108)

Item	Charting Correct (n)	Charting %	Outlining Correct (n)	Outlining %	Difference (%)
1	92	85.2	106	98.1	+12.9
2	78	72.2	83	76.9	+4.7
3	90	83.3	93	86.1	+2.8
4	83	76.9	66	61.1	−15.8
5	100	92.6	92	85.2	−7.4
6	83	76.9	71	65.7	−11.2
7	95	88.0	94	87.0	−1.0
8	108	100.0	92	85.2	−14.8
9	98	90.7	79	73.1	−17.6
10	89	82.4	95	88.0	+5.6
Mean	91.6	84.8	87.1	80.6	−4.2

Note: Values represent the number and percentage of participants (n = 108) answering each item correctly. Difference = Outlining % minus Charting %. Positive values favor outlining; negative values favor charting.

Table 2 shows the both conditions produced high absolute memory retention. Mean item-level accuracy was 84.8% for charting (range: 72.2%–100.0%) and 80.6% for outlining (range: 61.1%–98.1%). The item-level analysis reveals heterogeneous performance patterns within each condition: charting showed perfect recall (100%) on item 8 while its lowest accuracy was item 2 (72.2%); outlining showed near-perfect recall on item 1 (98.1%) while its lowest accuracy was item 4 (61.1%). This item-level heterogeneity suggests that differential item difficulty within each quiz rather than a systematic format advantage is a primary driver of score variation.

A notable pattern is that charting outperformed outlining on items 4, 5, 6, 8, and 9 (charting accuracy margins of +15.8%, +7.4%, +11.2%, +14.8%, and +17.6% respectively), while outlining outperformed charting on items 1, 2, 3, and 10. This bidirectional pattern is inconsistent with a systematic format advantage for either method and is more consistent with content-specific difficulty effects where certain topics or item types are inherently more accessible via one organizational format than the other.

4.2 Normality and Inferential Test Results

Table 3. Kruskal-Wallis Test Results: Memory Retention Scores by Cohort Group Within Each Note-taking Condition

No.	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Charting scores is the same across categories of cohort (IN).	Independent-Samples Kruskal-Wallis Test	.458	Retain H_0
2	The distribution of Outlining scores is the same across categories of cohort (IN).	Independent-Samples Kruskal-Wallis Test	.371	Retain H_0

Source: IBM SPSS Statistics version 22. α = .05. CH = Charting scores; OT = Outlining scores; IN = Cohort year (independent variable in Kruskal-Wallis test).

Table 3 present the Kolmogorov-Smirnov normality testing revealed that charting scores were non-normally distributed ($p < .05$), justifying application of the non-parametric Kruskal-Wallis test to both conditions. The Kruskal-Wallis test found no statistically significant difference in charting scores across cohort groups ($p = .458 > .05$) and no statistically significant difference in outlining scores across cohort groups ($p = .371 > .05$). The null hypothesis is retained for both conditions: cohort membership does not significantly predict memory retention performance under either note-taking format.

4.3 Discussion

4.3.1 Null Result: Interpretation and Theoretical Explanation

The absence of significant differences between the charting and outlining conditions is interpretable through multiple theoretical lenses. From a memory processing perspective (Shiffrin & Atkinson, 1969), both formats appear to have been equally effective at supporting the encoding and short-term retention of the presented material within the seven-minute study window. This equivalence may reflect the fact that both charting and outlining satisfy the fundamental requirements for effective encoding: organized presentation of information, logical grouping of related content, and visual differentiation of main ideas from supporting detail. When these basic organizational properties are met, the specific visual arrangement of the information (tabular vs. hierarchical) may not produce differential encoding depth for the types of recall tested.

An alternative explanation concerns the measurement design. Both quizzes assessed factual recall of specific content points a cognitively shallow retrieval demand that may not be sufficiently sensitive to differentiate encoding strategies that diverge primarily in their support for deeper conceptual or relational memory. Mueller and Oppenheimer (2014) found that format-related memory advantages emerged for conceptual recall tasks rather than factual recall; the multiple-choice format used in this study may have been inadequate for detecting the format-specific encoding benefits that outlining and charting theoretically provide for different types of information structure.

4.3.2 High Absolute Performance and Ceiling Effects

The high absolute accuracy rates in both conditions (charting 84.8%; outlining 80.6%) raise the possibility of a ceiling effect: when performance is already near the maximum, differences between conditions are statistically difficult to detect regardless of whether they exist in the population. Both formats appear to have been effective at supporting the immediate recall of the presented information within the brief retention interval between stimulus exposure and quiz administration. This observation suggests that future research should either extend the retention interval (testing recall at 24 hours, one week) to introduce natural memory decay, or increase the difficulty of the memory assessment to reduce ceiling effects.

Additionally, the absence of a statistically significant difference may indicate that note-taking format alone is not the primary determinant of short-term memory performance. Other factors, such as participants' prior knowledge, individual learning strategies, attention during material presentation, and familiarity with digital note-taking tools, may have contributed substantially to recall outcomes. Future studies should therefore consider controlling or measuring these variables to better understand

the conditions under which specific note-taking formats may provide a meaningful cognitive advantage.

4.3.3 Uncontrolled Variables

Several uncontrolled variables may have attenuated any true between-format difference. Individual differences in learning style, working memory capacity, and prior knowledge of the stimulus topics are documented moderators of note-taking effectiveness (Aprilia et al., 2019; Darouich et al., 2017). Participants with strong visual-spatial learning preferences may have benefited disproportionately from charting's tabular structure, while those with strong verbal-sequential preferences may have benefited more from outlining; these individual differences would produce heterogeneous responses that cancel in aggregate analyses. Motivational engagement during the Zoom-delivered session was not monitored; participants in online environments may have experienced varying levels of distraction and attentional engagement that introduced unsystematic variance in memory scores. The non-equivalent stimulus content across conditions (adulthood development vs. Kohlberg moral development) further complicates interpretation, as differences in topic familiarity, content density, and inherent memorability may have differentially affected retention scores independent of the note-taking format.

4.3.4 Practical Implications

The null result carries a practically meaningful implication: for students operating in digital learning environments where both charting and outlining formats are readily available, the choice between these two methods may be less important than consistent, attentive engagement with whichever format is used. The high accuracy rates in both conditions suggest that either format when presented in an organized and well-structured form is sufficient for supporting immediate memory of course content. Students may therefore benefit from choosing the format that aligns with their personal preference and the structural characteristics of the content being studied (comparative content for charting; sequential content for outlining), rather than seeking a universally superior format.

Furthermore, these findings support the view that effective learning outcomes depend not only on the external structure of notes but also on the cognitive processes involved during note-taking. The act of selecting, organizing, and encoding information may contribute more to memory performance than the specific format employed. Consequently, educators and instructional designers may focus on encouraging active engagement with learning materials and teaching effective note-taking strategies, rather than prescribing a single note-taking format for all learners and learning contexts.

5. Conclusions

5.1 Conclusion

This study examined whether digital charting and outlining note taking formats differ in their effects on immediate memory retention among undergraduate psychology students at Universitas Padjadjaran. Using a within-subjects design with 108 participants and Kruskal-Wallis non-parametric testing, no statistically significant difference was found between charting and outlining conditions (charting: $p = .458$; outlining: $p = .371$), retaining the null hypothesis. Both conditions produced high absolute memory accuracy (charting: 84.8%; outlining: 80.6%), and item-level analysis revealed bidirectional performance patterns inconsistent with a systematic format advantage for either method.

These findings contribute to the literature in three ways. Theoretically, they suggest that for immediate factual recall under equivalent study duration conditions, charting and outlining formats produce functionally equivalent memory outcomes, consistent with the prediction that basic organizational properties shared by both formats rather than their specific visual arrangement drive encoding effectiveness. Empirically, they provide the first direct experimental comparison of digital charting and outlining in an Indonesian higher education context, contributing to the growing literature on note-taking in digital learning environments. Practically, they suggest that students may prioritize content-format alignment (tabular charting for comparative content; hierarchical outlining for sequential content) and personal learning style preferences over format choice per se when selecting digital note-taking strategies.

5.2 Research Limitations

Five limitations qualify this study's findings. First, the non-equivalent stimulus content across conditions (adulthood development vs. Kohlberg moral development) introduces content-difficulty as an uncontrolled confound that prevents clean causal attribution of performance differences to note-taking format. Future studies should use matched content or counterbalanced topic-format pairings. Second, the fixed ordering of conditions (charting always preceding outlining) introduces order effects including practice (familiarity with the testing format improving performance on the second condition) and fatigue (reduced attention on the second condition); counterbalanced design would control this threat. Third, the online delivery via Zoom introduces uncontrolled environmental variability in attention, audio quality, and screen visibility. Fourth, the multiple-choice quizzes were not formally validated for psychometric quality; item difficulty and discrimination indices were not assessed. Fifth, the absence of a no-note-taking control condition prevents assessment of whether either format produces memory benefits over unaided study.

5.3 Suggestions and Directions for Future Research

Future research should address the identified limitations through several refinements. A counterbalanced design with two matched content materials each available in both charting and outlining formats would control both content effects and order effects simultaneously. A three condition design adding a no-note-taking control would enable assessment of whether format-specific memory benefits exist relative to unaided study, not merely relative to each other. Testing retention at extended intervals (24 hours, one week) would distinguish short-term working memory effects from long-term encoding benefits and allow natural forgetting to differentiate conditions with differential encoding depth.

Offline laboratory administration would enable closer experimental control of attention, distraction, and study behavior, addressing the uncontrolled environmental variability of the Zoom platform. Individual difference measures including validated learning style assessments, working memory span, and domain knowledge tests would enable moderation analyses examining for whom charting or outlining produces superior memory outcomes, providing more actionable guidance than aggregate null results. Research incorporating richer memory assessment formats including free recall and essay tasks alongside multiple-choice recognition would enable differentiation of recall and recognition memory effects, potentially revealing format differences that factual recognition quizzes cannot detect.

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Author Contributions

NW conceived and designed the study, supervised the research process, and led the manuscript preparation. ZAA, ARW, VD, SAP, and NNR contributed to data collection, participant recruitment, and experimental implementation. ZAA, ARW, and VD assisted in data management and statistical analysis. SAP and NNR contributed to the literature review and interpretation of findings. All authors participated in manuscript writing, critically reviewed the final version, approved the manuscript for publication, and agreed to be accountable for all aspects of the work.

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