

Our Notes Leave too Much to Say: Investigating Note-Taking Practices and Technological Tools in Academia

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Abstract: This paper explores the role of note-taking as a critical, yet under-researched, practice in academic scholarship, focusing on how researchers organize, synthesize, and reuse their notes in the context of knowledge production. While previous technological advancements such as large language models (LLMs) have transformed aspects of academic writing, fundamental cognitive tasks—such as capturing and synthesizing information through note-taking—remain relatively unchanged. Drawing from existing research, we highlight how poor or ineffective note-taking practices in both students and early-career researchers can lead to inefficient work processes and diminished synthesis of knowledge. Our study involves a small-scale survey of academic researchers to examine their note-taking techniques, tool usage, and strategies for synthesis. Our findings reveal that many researchers employ unstructured methods, such as the Sentence and Outline Methods, and lack formal training in effective note-taking. Furthermore, despite the availability of advanced digital tools, most participants continue to rely on familiar word processors, often limiting the reusability and efficacy of their notes. We argue that structured methods and better tool utilization could significantly enhance academic writing and synthesis. The paper suggests that future research should focus on developing note-taking tools tailored to researchers' needs, enabling more effective synthesis and the reuse of notes. Such tools could potentially integrate with LLMs to reduce the time spent on repetitive tasks and improve the quality of scientific output. This shift could lead to a paradigm where notes evolve from simple memory aids to valuable data that contributes directly to scientific advancement.

1 INTRODUCTION

Research and scientific advancement further the collective understanding of phenomena in any given society, writes Michel Foucault in his famous work "The Order of Things" (Foucault, 2020). Karl Popper argues that what researchers do is make statements on phenomena in the world (Popper, 2010). Thomas S. Kuhn enters prior knowledge into the mix in arguing that researchers need to first acquire a Paradigm through study and understanding of textbooks, before being able to conduct science (Kuhn and Hacking, 2012). Methods, axioms and influential prior research need to be known in any given field, before one can become a researcher oneself.

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If we consider the education of new scholars, researchers and scientists, we see these arguments in practise. Students learn from lectures, discussions, presentations, seminars and a plethora of other formats. They learn from the written and spoken word of their peers and teachers. But the delivery of knowledge is not the most crucial part of learning. In following Bloom's taxonomy of learning, we argue that in order to create scientific advancement, a researcher must first remember, understand, apply, analyse and evaluate knowledge, they acquired previously through reading, discussion or other means (Krathwohl, 2002).

To facilitate these steps, we derive that synthesis through notes, can be considered a major factor in prior learning, much in alignment with Kuhn's observations on how researchers acquire their Paradigm (Kuhn and Hacking, 2012). Note-taking can act as a second brain or "external storage" (Mosleh and Baba, 2013; Pitura, 2023; Mueller and Oppenheimer, 2014), which facilitates recollection in its simplest

form. Notes can be analysed and revised, a process also known as synthesis (Qian et al., 2020).

As for application, note-taking, should be considered an exercise in academic writing, which we consider in itself to be among the most fundamental skills any researcher or scholar will use in their career in academia. However, with more and more capable LLMs, a focus on the mere mass-production of scientific publications, as we see today, can certainly be considered obsolete.

Following from these arguments, we say that notes are the de facto bedrock of any scientific work. Qian et al. consider them to be building blocks in a sense making process (Qian et al., 2020), which in itself is, as argued, fundamental to science.

However, from anecdotal evidence, we observed that not many researchers seem to be trained in note-taking. In this paper, we want to provide a baseline and explore how researchers in academia take and use their notes, with a specific focus on the employed note-taking techniques and strategies.

1.1 Note-Taking as an Integral Part of Research and Synthesis

The practise of note-taking itself is age-old and began, according to Ślęzak Świat, with annotations in margins to better interpret a text. While the practise of these in-source annotations can be traced as far back as 500CE (cf. (Ślęzak Świat, 2022)), digital note-taking, according to Joanna Pitura's recent overview on the subject, started with the use of word-processors and developed into specific note-taking software like 'Evernote' or 'RoamResearch' (Pitura, 2023). Notes and marginalia can be found to be so encompassing that they can even serve as publications of their own. One such example is Wittgenstein's "Über Gewißheit" (On Certainty), which he could not finish before his death in 1951 (Wittgenstein, 2020). It was nevertheless published and, despite its fractured appearance, it allows an interesting view into his thought process and renders them as understandable as other scientific publications. The same happened to J.R.R. Tolkien's work *The Silmarillion*, which was also published unfinished after his death.

While the publication of notes, may – as in Wittgenstein's case – lack, a well-structured reading experience, the practise of note-taking offers many benefits, even beyond scholarly fields, as note-taking aids in decision-making and problem-solving. It also improves (academic) writing and information retention (Deniozou et al., 2020; Pitura, 2023; Ślęzak Świat, 2022). It does so mostly through the process of encoding knowledge, i.e. writing down informa-

tion in your own words, often by hand (Ślęzak Świat, 2022; Pitura, 2023; Mosleh and Baba, 2013; Mueller and Oppenheimer, 2014)). Qian et al. argue that note-taking, is a scholarly primitive. It forms the basis of synthesis, which itself is the basis of producing new knowledge and scientific advancement from previous sources (Qian et al., 2020). Note-taking is part of a (scientific) discourse (Ślęzak Świat, 2022), notes are purpose-driven if used for scientific writing, and should not be mere documentation (Fix and Dittmann, 2008; Pitura, 2023). Effective note-taking can speed up the process of scientific writing tremendously. Fix and Dittmann argue that well-executed notes, will allow for the construction of a text without reading the corresponding primary sources again (Fix and Dittmann, 2008), thus providing an ever-growing collection of building blocks for further construction of texts that pertain to the same discourse.

In practise, however, Qian et al. found that their participants often had to return to their sources, correcting misunderstood parts in their notes, or finding their notes inadequate (Qian et al., 2020), indicating less well-executed notes. The fact that other studies found students to be having trouble taking effective (especially digital) notes (Fix and Dittmann, 2008; Ślęzak Świat, 2022; Mueller and Oppenheimer, 2014), indicates a greater, systemic issue.

In 2024, Kathleen Carroll provided an overview of the state of research on the benefits of note-taking and what cognitive functions it applies in students (Carroll, 2024). Concerning digital note-taking, specifically, Joanna Pitura published an overview in 2023. It provides a comprehensive study on (digital) note-taking and tool usage in students and early career researchers. She analysed the benefits and usage of specific tools and techniques in use by her target group (Pitura, 2023).

Touching on a similar subject, Mueller and Oppenheimer conducted a study in 2014, in which they analysed whether students performed better at taking lecture notes using a laptop or long form writing (Mueller and Oppenheimer, 2014). They found that students using a laptop were prone to transcribing part of the lecture verbatim, which lead to ineffective notes and poor recollection (Mueller and Oppenheimer, 2014). Mueller and Oppenheimer argue that due to laptops allowing for more words to be written in a given time span, they encourage ineffective note-taking (Mueller and Oppenheimer, 2014). Verbal interventions proved ineffective in mitigating the behaviour (Mueller and Oppenheimer, 2014). However, we argue that a lack of training on on-the-spot synthesis may also adequately explain the lack of performance, as opposed to the use of technology itself.

Long form writing necessitates this synthesis due to the constraints Mueller and Oppenheimer identify. If students were properly trained beforehand to treat a laptop the same way as they would pen and paper, they may not have fallen for the temptation of mindlessly transcribing. Umberto Eco mentions a similar effect in 1977, when he reminds his readers to not simply photocopy texts and then consider them read (Eco, 2015). Reliance on a photocopier alone, instead of reading and synthesising, leads to poor understanding of the subject and poor performance in writing.

While note-taking and its apparent benefits are well understood in the work of students, research concerning note-taking as a scholarly practise in academic work is poorly examined and its influence on synthesis and knowledge production is under-researched (Qian et al., 2020; Carroll, 2024; Pitura, 2023; Deniozou et al., 2020), (Mosleh and Baba, 2013), (Pitura, 2023). Qian et al. performed in 2020 a small-scale qualitative study on first-year PhD students in their research group, where they researched how their participants performed sense-making and synthesis (Qian et al., 2020). In the process of this study, some insights were gained on how the participants used notes and digital tools to facilitate synthesis. However, their conclusion was the same that was hinted at earlier in the introduction. Their participants repeatedly had to return to their sources to correct their notes, rendering them ineffective (Qian et al., 2020). They also identified a lack of tools and proper training (Qian et al., 2020).

The research presented suggests that issues concerning poorly executed notes present themselves in students (Mueller and Oppenheimer, 2014) and researchers alike (Qian et al., 2020), suggesting a knock-on effect from poor or ineffective training.

1.2 Contribution

The contribution of this paper is to understand how note-taking is done in academia and explore whether the systematic issues observed with students are also presented with our target group. To facilitate this, we undertook a small-scale survey to achieve a baseline understanding of the situation. We aim to understand how notes are used among our participants. We also aim to identify how note-taking strategies are employed and how structured the process of note-taking is in our participant's day-to-day work. We also aim to corroborate our findings with findings from previous research. In doing so, we aim to further increase the understanding of systematic issues that present themselves in the practise of note-taking in researchers and scholars and, if issues present it-

self, offer ideas on how they could be solved in further research.

2 SURVEY

To see, whether any of the aforementioned issues were present or prevalent in Academic research, we conducted a survey in note-taking techniques and strategies.

The survey (see Appendix for the survey questions) was inspired by an overview on note-taking methods and strategies by Mosleh and Baba, published in 2013 (Mosleh and Baba, 2013). As they implied that these techniques were widely used in academia, we deemed them a good selection for our survey. Furthermore, they were the only encompassing overview we found. The methods outlined by Mosleh and Baba can also be found in multiple educational web-portals, such as for example <https://e-student.org>.

The techniques and strategies, Mosleh and Baba provide, range from less structured methods like the Sentence Method, or Outline Method where note-takers write their thoughts and other information as unstructured sentences, or as indented sentences below a topic respectively, to well-structured, tabular methods like Two-Column-Reading or the Cornell Method, where note-takers write down notes, cues and reasoning in specific columns or partitions on a page. (Mosleh and Baba, 2013).

In Two-Column Reading, note-takers split the page into two columns. One of them contains the information taken from the currently read text, while the other contains thoughts and reasoning on the note taken ((Mosleh and Baba, 2013)).

The Cornell Method structures notes in three columns, containing a cue word, the thoughts of a note-taker when the cue was encountered and a summary of the page of notes, is also mentioned by Pitura as an example for digital note-taking (Pitura, 2023).

Another well-structured method we selected was not in Mosleh and Baba's overview. In Four Column Reading, note-takers split a page into four columns. One contains a quote or paraphrase the note-taker has encountered, the second column contains the number of the page, where the quote or paraphrase was taken from. The third column contains the reasoning of the note-taker, as to why they selected the quote or paraphrase and how it pertains to their research question. A fourth column contains information on where the specific information is to be used in an article or other form of scientific text (Király et al., 2023).

Other structured methods also include the REAP-

method (Mosleh and Baba, 2013), where information is read, encoded, annotated and pondered, i.e. notes are taken (encoded), collated in any way (annotated) and synthesised (pondered). Furthermore, mapping methods, such as mind maps and charting methods, where information is encoded into a table or a spreadsheet (Mosleh and Baba, 2013) can be considered structured as well.

The survey was designed with 20 mostly yes/no or multiple choice questions (see Appendix). Only a few questions allowed for open-ended 'other' options. The answers to the open-ended options were encoded by hand for analysis. The language chosen for the survey was English.

The survey was hosted on a LimeSurvey platform, hosted by a German research institute. Participants were invited using Messengers, Chatrooms, Social Media and E-Mails. It was not recorded where participants currently work. This was considered of little interest, and would possibly have allowed for the identification of individuals. No personal data was recorded, rendering the survey anonymous.

2.1 Findings

The target audience of our study was considered to be active researchers in academia. The link to the survey was distributed using emails and Social media channels. In total 33 participants completed the questionnaire.

To better understand where participants were in their academic career, we asked their current position (Q. 1). Three options were given: **Predoc**, i.e. PhD candidates, graduate students and the like, **Postdoc** and **Professor**. To better identify cohorts, these terms will be used from this point on to refer to the respective groups outlined in 1

Table 1: Career stages of participants.

Career stage	Number of participants in cohort
Predoc	20
Postdoc	9
Professor	4
Total	33

We hoped to get a better understanding of note-taking techniques in specific fields, so we asked participants in what academic field they currently work (Q. 3). The results were distributed with a long tail, thus not usable for statistic evaluation, beyond observing what fields were present. The two biggest cohorts were Computer Science (N=6) and Psychology (N=9). However, the spread included a wide range of academic fields such as Art History, History, Archival

studies, Linguistics and Education among others.

Since we also wanted to allow a wider, international group to participate. Our participants were mostly of German nationals, or persons having received their academic education in Germany. Thus, the question concerning where academic education was received (Q. 2) did not yield any valuable insights.

2.1.1 Reading and Note-Taking Strategies

The question most relevant to the goal of this paper was what reading and note-taking strategies were employed by participants and gave the aforementioned techniques as options. (Q. 11) Since we expected multiple techniques to be employed by a single participant, multiple answers were allowed. 'None of the Above' excluded all other answers. We found that overall, none of the very structured methods were employed widely.

In Predocs (N=20), only three methods could be considered popular. These were the Outline- (N=7), Mapping- (N=5) and the Sentence Method (N=4).

Postdocs (N=9) used slightly more structured methods in using Outline Method (N=2), Two-Column Reading (N=2) and the Sentence Method (N=3).

Among Professors (N=4) no real trend could be observed, but Outline Method (N=2), Mapping Method (N=2) and Sentence Method (N=2) were the most prevalent.

Among all groups, 'None of the above' ($N_{Predocs}=8$, $N_{Postdocs}=2$, $N_{Professors}=1$), was used frequently as well. This indicates that a not insignificant portion of our participants do not use, or do not know of, the techniques we proposed as answers.

2.1.2 Digital vs. Print, Screen Inferiority

Since previous research indicated a strong screen inferiority effect for academic reading and note-taking (Ślęzak Świat, 2022), we decided to include questions on reading habits. When asked about whether participants predominantly read their sources in print or on screen (Q. 5), most participants, through all cohorts, stated that they read their academic texts either on screen ($N_{Predocs}=8$, $N_{Postdocs}=3$, $N_{Professors}=2$) or both on screen and paper, or they could not say ($N_{Predocs}=6$, $N_{Postdocs}=4$, $N_{Professors}=2$). Only a minority stated to read on print-outs ($N_{Predocs}=6$, $N_{Postdocs}=6$, $N_{Professors}=0$).

Furthermore, we asked whether participants preferred handwritten notes or used word-processors or wrote notes directly in text (annotations) or used dedicated note-taking software. (Q. 6). The use of word

processors and handwritten (long form) notes is most prevalent, as can be seen in table 2.

Table 2: Distribution of note-taking habits.

	Predoc	Postdoc	Professor
Handwritten notes	13	6	3
Word processor	13	5	2
Annotations	5	4	1
Dedicated Software	1	2	1

As a follow-up question, we asked participants whether they preferred handwritten notes on paper, or took them using digital means (Q. 7). Almost all participants, through all cohorts, stated they made handwritten notes on paper. Even those who made handwritten notes digitally, also made paper notes (3).

Table 3: Distribution of handwritten notes on paper vs. on screen (Multiple Answers allowed).

	Predoc	Postdoc	Professor
Handwritten notes on paper	12	5	2
Handwritten notes on screen	7	2	2
Both	6	1	2
Total	13	6	3

We also asked whether annotations (notes directly in the source material) were used and whether they were taken on paper or digitally (Q. 9). The results can be seen in table 4

Table 4: Distribution of annotations on paper vs. on screen.

	Predoc	Postdoc	Professor
Annotations on paper	3	2	1
Annotations on screen	4	3	1
Both	1	1	1
Total	5	4	1

2.1.3 Tool Usage

Among our participants, dedicated note-taking software was only widely used in the professor (N=2) cohort. Among Predocs (N=1), and Postdocs (N=2), dedicated note-taking software was not widely used. (See table 2).

The software in use was Evernote (N=2), Obsidian (N=2), Roam Research/LogSeq (N=2) and Google Keep (N=1).

Overall, the most widely used tool were word processors. Among them, Microsoft Word (N=13) was the most commonly used, with the Google Suite being a distant second (N=3).

2.1.4 Quality of Notes

To assess the quality of notes that our participants took, the question was posed whether participants did publish their notes (Q. 16). The reasoning behind this question was that if participants published their notes, we could assume that they had faith in their notes and would hold them to a high quality standard. Furthermore, we assumed that researchers who published their notes considered them as research data to be reused and shared. The vast majority (N=29) did not publish their notes, with only a very small number (N=4) publishing them. (see table 5)

Table 5: Question: Do you publish your notes?

	Predoc	Postdoc	Professor
Yes	3	1	0
No	17	8	4

To further assess the perception of the quality of the notes participants took, we asked for reasons why the participants choose not to publish their notes (Q. 18). Since multiple of the offered reasons might apply, multiple answers were allowed. As seen in table 6, most participants considered their notes to be private. However, quite a large number of participants (N=13) voiced concerns that their notes may (also) contain errors. Only a small minority stated that their notes were useless due to being idiosyncratic (N=4). Interestingly, a small number of participants stated that they did not publish their notes because they may contain cues for further research by others.

Table 6: Reasons why notes would not be published.

	Predoc	Postdoc	Professor
My notes are private	13	6	3
My notes may contain errors	7	3	3
They may contain cues for further research	3	1	1
They would not make sense to others	2	2	0

2.1.5 Note Usage

Since reasoning and other meta-information may be encoded with different schemas, we also asked if note-takers wrote their own reasoning, reading strategy and mental disposition (Qs. 12–14). Király et al. argue that they all can influence the note-takers perception and argumentation during critical reading (Király et al., 2023).

We also wanted to evaluate how our participants used their notes in their writing process (Q. 19). Since notes can be used as building blocks to scientific texts or as memory aids, we posed whether our participants used them as such. We also asked if participants included their own reasoning in their notes. Since not many participants employed structured note-taking techniques that included reasoning by default ($N=2$), this question is of particular interest.

The majority of participants ($N=23$), through all cohorts, claimed to include their own reasoning in their notes, with only a minority not including their reasoning in their notes ($N_{Predocs}=7$, $N_{Postdocs}=1$).

Among these participants, only the Mapping Method ($N=1$) was used as an example of a structured note-taking method. The remaining distribution of techniques used by participants who, do not include their reasoning, can be seen in table 7. None of the methods compel the note-taker to include reasoning.

Table 7: Note-taking methods employed by participants not including their own reasoning.

	Predoc	Postdoc
Outline Method	1	1
Mapping Method	1	0
Sentence Method	3	1
None of the above	3	0

Furthermore, participants were asked if they used their notes as memory aids or text snippets. Since both usages may coexist, multiple answers were allowed. The category 'both' is calculated from the answers, to allow for better analysis. An open-ended option was given, but no comment was provided by most participants who choose it. These answers were ignored as invalid ($N_{Predocs}=1$, $N_{Postdocs}=1$). One answer was given as 'I use my notes as outlines', which we encoded as 'text snippet' (See table 8).

The Predocs were the only cohort to show a widespread usage of notes as text snippets or both snippet and memory aid ($N=14$). Postdocs, used their notes mainly as memory aids ($N=6$). Among professors, usage as a memory aid was dominant ($N=2$).

Table 8: Note usage.

	Predoc	Postdoc	Professor
Cohort size	20	9	4
Use as snippets (only)	4	0	1
Use as memory aid (only)	6	6	1
Both	10	2	1
Other (invalid)	1	1	0

2.1.6 Training

We wanted to explore whether participants have received training in note-taking (Q. 15). The results show that, through all cohorts, most participants stated that they either received no training or were self-taught ($N_{Predocs}=18$, $N_{Postdocs}=7$, $N_{Professors}=4$), which could be considered the same in the context of this question. Only the minority of participants stated to have received training in school or university ($N_{Predocs}=7$, $N_{Postdocs}=6$, $N_{Professors}=0$). For a detailed overview, see table 9.

Table 9: Note-taking training received.

	Predoc	Postdoc	Professor
Cohort size	20	9	4
School	3	3	0
University	4	3	0
Self-taught	6	5	1
I did not receive any training	12	2	3

2.2 Discussion of Findings

Among our participants, none of the structured methods that Mosleh and Baba claimed to be widely used (Mosleh and Baba, 2013) were found to be prevalent. Our participants tended to prefer unstructured methods, that encoded information without (Sentence Method) or with simple, hierarchical structures (Outline Method). While Mapping Methods, such as mind maps, were the most structured method used in our participants.

Furthermore, we observed that only a minority of participants ($N=10$ out of 33) annotated their sources, indicating a single step reading process, which is further correlated by the absence of the REAP-Method.

More critically, our findings show a lack of formal training, aligned with a conclusion of Fix and Dittman made in 2008 (Fix and Dittmann, 2008). Similarly, Ślęzak-Świat's research in 2022 suggested that her participants, Polish E2L students, had little knowl-

edge about structured note-taking techniques and no formal training. Thus, they relied on their intuition (Ślęzak Świat, 2022). The studies done by Qian et al. and Mueller and Oppenheimer further support this notion (Qian et al., 2020; Mueller and Oppenheimer, 2014). As outlined above, the findings of Mueller and Oppenheimer can well be explained by a lack of training, rather than by the use of technology.

This correlates well with our findings, since the Sentence- and Outline Methods can be considered intuitive, as they do not rely on any structure that would necessitate training and knowledge. Thus, based on our results, we consider that more training is needed to get more structured and reusable notes.

Taking into account that Fix and Dittmann observed a lack of training as early as 2008 (Fix and Dittmann, 2008), the deficit we perceive has persisted for quite some time. Any lack of training and knowledge we observe today, we consider to be knock-on effects of prior insufficient training, since the students of 2008 may well be teachers today.

Since a larger number of our participants consider themselves self-taught (N=12), we could assume that they read training resources themselves. There are more recent training resources like, for instance, Király et al.'s 'Jump-Start Your Writing' (Király et al., 2023), or even older manuals like Umberto Eco's 'How to write a thesis', originally published in 1977 and translated into English in 2015 (Eco, 2015) that show usages of more structured techniques. Király et al. propose four-column-reading (Király et al., 2023), while Eco, being an older resource, does not include computerised methods. He proposes the use of index cards and files in filing cabinets (Eco, 2015), a technique that is still employed by some researchers today (McCarty, 2023). This list is by no means exhaustive.

However, since we observed a near absence of structured methods present in teaching materials, we can assume that our participants, while considering themselves self-taught, did not consult these materials, or did not feel the need to do so. This raises the question if the notion of self-teaching rather more refers to 'make it up as you go', than actual course-work.

While structured methods for note-taking are not part of the daily work of our participants, we found that a sense of efficacy in note-taking was well represented. Our findings suggest that the new generation of researchers, represented by our Predocs cohort, use their notes as text snippets to a significant degree, whereas in our Postdocs cohort they were still mainly used as memory aids.

The use of notes as parts of a new text is one of the key concepts of Four-Column-Reading, and we argue

that it shows a concern of efficacy and reusability in note-taking. It also indicates that a degree of synthesis that must have been taken place, if notes were considered to be incorporated into a publication. This is further corroborated by the fact that the vast majority of our participants included their own reasoning in their notes. While the lack of training may still present issues, we argue that it could be offset by the use of tools that are specifically designed to reevaluate, synthesise and manage notes in ways described by, for example, Pitura, Eco, or McCarty (Pitura, 2023; Eco, 2015; McCarty, 2023). We also argue that the necessary structure for reuse may also be introduced by the use of specific tools.

Tool usage in note-taking, however, also shows signs of knock-on effects that can be traced to a lack of formal training in students and teachers alike. While there is a plethora of dedicated note-taking tools (RoamResearch, Evernote, LogSeq, Obsidian, Google Keep, Notion.io, Zettelkasten¹ to name a few), their use did not present itself in our findings. We assume our participants used the tools they are familiar with, which are mainly word-processors in the form of Microsoft Word. Its use is usually taught in schools, and it is omnipresent. This aligns well with findings from Qian et al., who also observed that their participants did not use dedicated note-taking tools. Their participants often showed a 'make-do' attitude in adapting known tools to a use they were never designed for and which thus offered sub-par performance on the task at hand. One participant went as far as using a built-in sticky-note tool in their computer's operating system to take their notes (Qian et al., 2020). While their participants clearly sought and found creative ways to employ their known tools, Qian et al. found it to be a source of friction, with researchers switching between up to four (adapted) tools to perform their daily work (Qian et al., 2020), hampering their abilities.

Pitura, McCarty, Király et al. and Eco present in their works methods that could reasonably be computerized and in the case of 'Zettelkasten' are even available as finished product. But knowledge of these tools did not present itself in our findings. To establish specific reasons, further research would be required, though we assume from anecdotal evidence that tools might simply be unknown.

Another indicator that correlates well with a lack of formal training is what we perceive as the employment of a single pass reading strategy. We deduce this from the lack of annotations our participants make in their sources. This aligns well with research done by Ślęzak-Świat in 2022, where she found that while her

¹<http://zettelkasten.danielluedecke.de/>

participants still read on paper, they did not annotate their printouts (Ślęzak Świat, 2022). While Ślęzak-Świat interpreted this as a strong screen inferiority effect in reading (Ślęzak Świat, 2022), we argue that it may also be a symptom of a lack of formal training. Resources like Király et al. teach a multistep reading process while taking notes (Király et al., 2023), whereas Eco advises to underline and annotate important parts on a photocopy (Eco, 2015). The lack of such annotations in a source may indicate a single-step reading process, which would align well with the observation that participants use intuitive methods. However, to ascertain this, more research would be required.

To establish a measure on how our participants perceived their own notes, we asked if they published their notes. Our participants generally answered they did not. They mostly considered their notes private or containing errors as a reason for not publishing. Previous research suggested that note-takers mainly perceived their notes to be unintelligible to others (Mosleh and Baba, 2013; Fix and Dittmann, 2008). Our findings differ concerning on this perception. While unintelligibility may be a reason for keeping notes private, 'being wrong' seemed to be a bigger concern to our participants compared to previous studies.

As a caveat, it has to be stated that our survey's participants consisted of a rather small group of mostly German academics. As stated above, our sample consists of a wide range of research fields, all of whom showed similar answers. As such, the context of the education did not seem to matter, and the issues highlighted in this paper persist in a variety of circumstances and fields. We furthermore found that the issues were already persistent in 2008 in German schools (Fix and Dittmann, 2008). And judging by the examined research, we do not expect other countries to be different. The knock-on effects described can be expected to manifest themselves in different countries and similar circumstances as well.

3 CONCLUSION

In general, our findings suggest that our participants do not use their notes to their full potential, even though small changes in behaviour could be observed to what was concluded in previous research. We argue that the main issue is a lack of teaching and training on how to take reusable and structured notes, and a lack of knowledge on tools that would help in this task. If available tools were simply inadequate, could not be ascertained.

While we argue that training and knowledge cannot be replaced by technology, we find that a dedicated tool may help researchers in obtaining better structured notes that can make synthesis easier and more reliable.

The tool we envision, would need to be akin to a 'Virtual Research Environment (VRE)' or a Dashboard, which would allow researchers and scholars more efficient and effective ways to remember, understand, analyse, and evaluate their notes and possibly publish them as research data alongside their publication, allowing for other researchers to integrate them in their work. We argue that with a VRE specifically designed to work through the act of note-taking, we could employ Natural Language Processing and other computerized methods, to make annotations in new transcripts, notes or machine-actionable texts that would allow researchers to see emerging patterns in notes and sources alike. The ability to annotate a researcher's own notes, as if they were a qualitative dataset, could also enhance further analysis.

While this additional step may require a change in habit, we argue that it will make notes more powerful and enhance the work of researchers, while they mostly keep working in the way they are accustomed to, using Outline- and Sentence Methods or mind maps. Mind maps in turn can help researchers organize their thoughts, generate ideas, and develop concepts, which enhances their analytical and understanding skills (Shi et al., 2023). Similarly, 'visual programming' could be employed to use the visual aspect of mind maps to visualise steps in an analysis with different algorithms connecting to one another. At the time of writing, we are not aware of any tool that would implement the functionalities we envision.

An encompassing VRE could also solve another problem in data reuse. Because, even if notes are taken using structured methods, they are currently neither published nor reused. We assume that in writing, analysing and learning, researchers seldomly use all the notes they made, rather they use a portion that pertains to a specific topic or question. With the current tools in use, we expect the rest to fall by the wayside, lost in some word-document somewhere never to be seen. With dedicated tools, these unused notes can be exported, shared or be reused and synthesised in another context. In this sense, note-taking supports learning and thus also research, through a constructivist approach to learning. This approach allows note-takers to use their notes in different scenarios and contexts, allowing for new connections and a broader understanding (Friedman, 2014). Furthermore, since notes created within an encompassing

VRE share a common mode of production, we argue that these notes are as scientifically valuable as any qualitative, incidental data.

Following this, notes themselves may even form a new basis for publication. Ślęzak-Świat argues that notes, as a stand-alone publication, act as an indicator to what texts a researcher may have read and which information they did not deem necessary to their process. Notes can thus act as an indicator of a researcher's attention and focus (Ślęzak Świat, 2022). While this aligns with our previous arguments, it can directly be confirmed by reading "Über Gewißheit", where Wittgenstein's notes allow the reader a glimpse into his thought process while examining a philosophical article, argument by argument. Also, a collection of notes from different researchers might indicate the attention and focus of an entire field, show a structural bias or blind spots or illuminate a hitherto unknown paradigm in the sense of Thomas S. Kuhn (Kuhn and Hacking, 2012), or expose the episteme (Foucault, 2020) or 'Weltbild' (Wittgenstein, 2020) of a group of researchers.

As such, evaluation of available tools is still ongoing and the reuse of notes and the perception of notes as a form of research data is something that needs to be studied more in-depth.

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APPENDIX

Survey Questions

Q1: At what stage in your academic career are you currently?

Answer options (Single Choice):

- Student
- PreDoc (PhD candidate, Post-grad-student)
- PostDoc
- Professor
- I don't/no longer work in academia

Q2: In what country did you receive your academic education?

Answer options (Free text field)

Q3: What's the scientific discipline you currently work in? Or, if you don't / no longer work in academia, what's the field you last worked in or studied.

Answer options (Free text field)

Q4: Do you take notes?

Answer options (Single Choice)

- Yes
- No

Q5: Do you prefer to read material printed on paper, or do you primarily read on a screen?

Answer options (Single Choice)

- Print
- Screen
- Both/Can't really say

Q6: How do you take your notes?

Answer options (Multiple Choice)

- Handwritten
- Word Processor / text editor
- Notes directly in text
- Dedicated note taking software
- Other (i.e. Sketch notes, Mindmaps, Doodles etc.) (Free text field)

Q7: Do you take your handwritten notes on paper or do you take them digitally?

Answer options (Multiple Choice)

- On Paper
- Digitally

Q8: Which word processor or editor do you use?

Answer options (Multiple Choice)

- Microsoft Word
- LibreOffice / OpenOffice
- SublimeText
- Visual Studio Code
- Apple Pages
- Other (Free text field)

Q9: You write your notes directly into the text you're reading. Do you do so on paper or digitally?

Answer options (Multiple Choice)

- On Paper
- Digitally

Q10: What dedicated note-taking software do you use

Answer options (Free text field)

Q11: During note-taking, do you employ one or more of these techniques or strategies?

Answer options (Multiple Choice)

- Four Column Reading (Quote or Paraphrase, Page No., Comment or Reasoning, Where to use)
- Two Column (Notes and Notes-on-notes)
- Cornell Method (Three columns: Cue, Notes and Page-summary)
- REAP Method (Read, Encode, Annotate, Ponder)
- Outline Method (Indented bullet points, grouped by overarching subjects)
- Mapping Method (i.e. Mind Maps)
- Charting Method (Tabular notes)
- Sentence Method (Unstructured notes in full sentences)
- None of the above²

Q12: Do you record your chosen reading strategy in your notes?

Hint given: Reading strategies are for instance: Skimming, Close Reading, Critical Reading and the like.

Answer options (Single Choice)

- Yes
- No

Q13: Do you record your current state of mind in your notes?

Answer options (Single Choice)

- Yes
- No

²This option excluded all other answers.

Q14: Do you include your own reasoning in your notes?

Answer options (Single Choice)

- Yes
- No

Q15: Where did you learn to take notes?

Answer options (Multiple Choice)

- School
- University
- Self-taught
- I did not receive any training³
- Other (Free text field)

Q16: Do you publish your notes? Or, hypothetically, if you took notes, would you publish them?

Answer options (Single Choice)

- Yes
- No

Q17: How do you publish your notes?

Answer options (Multiple Choice)

- As research data in a repository
- As bundle with the publication
- On Github
- Other (Free text field)

Q18: Why do you choose to not publish your notes?

Answer options (Multiple Choice)

- My notes are private
- They may contain errors
- They may contain cues for further research
- Other (Free text field)

Q19: When you write, how do you use your notes?

Answer options (Multiple Choice)

- As text snippets
- As a memory aid
- They may contain cues for further research
- Not at all⁴
- Other (Free text field)

Q20: Given, you would use any software in note-taking. Would you prefer a cloud-based solution or would you prefer to store the notes on your local machine?

Answer options (Multiple Choice)

- Cloud Service (OneDrive, Apple Cloud, Google Drive or similar third party service)
- Owned Cloud (A cloud service you or your employer control, i.e. NextCloud, OwnCloud or similar)
- Local Network storage (i.e. Your own NAS, Shared drive at work)
- Local Device
- I don't use software⁵

³This option excluded all other answers.

⁴This option excluded all other answers.

⁵This option excluded all other answers.