

Student Notetaking Media in Higher Education

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Abstract: This paper explores the evolution of research methodology in the study of student notetaking in higher education (HE) and its impact on pedagogic approaches. While acknowledging the importance of notetaking for student learning, the paper argues that the overreliance of randomized control trials (RCTs) has led to some potentially misleading conclusions about lectures in HE and the notes students make during them. The paper traces the historical development of research methodologies in student notetaking, highlighting the shift from early observational studies to experimental research focused on identifying effective notetaking styles. However, the paper contends that these experimental studies often failed to capture the complex real-world factors that influence student note taking behaviour and learning outcomes. Contradictory findings between experimental and observational research are presented, challenging the assumptions drawn from RCTs. Observational studies suggest that the quality and quantity of notes taken during lectures may have limited impact on long-term conceptual understanding and learning outcomes, while the revision and review process may play a more significant role. The paper also examines the issues of internal and external validity in experimental research on student notetaking. It argues that the experimental methodologies used in these studies often controlled for important contextual factors, resulting in misleading outcomes that do not translate well into real-world settings. Drawing on the concepts of holist underdetermination and auxiliary hypotheses, the paper emphasizes the need for mixed methodologies and a holistic approach to investigate and establish causation in the study of student notetaking. In conclusion, the paper suggests that a shift in focus from student notetaking to the lecture itself may be necessary. It highlights the importance of considering the broader context, individual differences, and the review and revision process in understanding the impact of notetaking on student learning outcomes. The paper calls for a re-evaluation of experimental methodologies and a more comprehensive approach to studying student notetaking in higher education

Keywords: notetaking, higher education, research methods

1. Introduction

Although it was the start of the twentieth century before any formal research was published on the subject, the importance of notetaking by students was acknowledged as far back as the Roman era, Quintilian asserting that it was, 'the only way to ensure real, deep-rooted progress' (Quintilian, 2001, p. 79). As Higher Education (HE) expanded and class sizes grew, academics started to take an interest in what notes students were taking during lectures, and how those notes impacted student outcomes. The research generated over the last century has informed both academic practice and the study skills advice provided to students. This paper argues that the more recent overreliance on randomised control trials (RCTs) has led to some (potentially damaging) misconceptions about lectures in HE, and the notes that students make in them.

The short history of research into notetaking by students in HE is a fascinating reflection of other areas of research which appear to go through similar stages of development. Echoing those of natural science, even biology, where early research was observational, there was then (and is still) a great deal of experimental research, but now there is an acknowledgement that individual biological components can behave in unexpected ways when combined into complex systems. This has led to the development of entirely new fields of study such as Systems Biology, in which sophisticated computational approaches can now successfully model multiple interdependencies and is used to predict the efficacy of cancer treatments for instance. The research methodology on student notetaking has yet to reach the point of such sophisticated modelling.

This paper briefly explores the evolution of research methodology into student notetaking in HE and its impact on pedagogic approaches. It questions the external validity of RCTs in relation to student notetaking practices using Duhem's concept of 'underdetermination' in conjunction with an analysis of some specific examples compared to observational data.

2. Methodology

This paper employs a literature review and critical reflection to explore the evolution of research methodologies in the study of student notetaking in higher education. It critically analyses existing research literature, including both experimental and observational studies, to assess the strengths and limitations of different methodologies. The paper synthesises findings from multiple sources and presents a nuanced understanding of the complexities involved in studying student notetaking. By examining historical trends and contrasting experimental results

with observational data, the paper highlights the contextual factors and auxiliary hypotheses that are often overlooked in experimental research. The methodology employed in this paper involves a comprehensive review and synthesis of existing literature to provide a broader perspective on the research on student notetaking in higher education.

3. Evolving Research Methodology

Initially the research into student notetaking was observational, interested in what the students were doing of their own volition and what correlation that had with test scores. For example, Crawford (1925) identified a strong positive correlation between the quantity of notes taken and students' test results. He noted the difficulty of ascribing causality due to the myriad of possible influences on the note taking and the learning, including the fact that some lecturers forbade the taking of notes so that, students would get 'their ideas rather than their words' (ibid). For much of the next three decades research focused on the *product* of notetaking, trying to identify whether any particular styles of notetaking were more effective than others in aiding recall.

There is considerable debate as to what constitutes learning and how that should be assessed, and in notetaking studies especially, the area of recall versus conceptual understanding. However, for the purposes of this discussion, programme test, or exam scores are used as the measure of success.

As with other fields of study, 'causation is the "holy grail" of educational research' (Cohen et al., 2011, p. 54), and by the 1960s and 1970s researchers were taking more of an interest in the *process* of notetaking, and whether the act of writing things down had any intrinsic value. Di Vesta and Gray (1972) introduced the idea of notes as *external storage* which could be used for later retrieval. The theory of notes as external storage spawned nearly thirty years of experimental research which tried to isolate, identify, and control the ways in which this might happen.

To be able to claim causality the researchers had to control for as many extraneous influences as possible. Therefore, the majority of this experimental research required that the students take part in lectures on subjects with which they were not familiar, so as not to taint the data with any previous knowledge that individual students may have had. They were often instructed to use a particular style of notes such as transcription or summary. And, in order to keep the subjects of the study engaged and the data manageable there was often only one lecture, typically no more than ten to fifteen minutes in length. RCT groups are also common in these experiments to further isolate the effects being studied.

The results of the experimental notetaking studies seemed to be conclusive, with both valid and reliable outcomes in most cases. For instance, that summarised or paraphrased notes were better than transcription, and that, skeletal lecture slides were better than complete lecture slides. Skeletal (or incomplete) lecture slides/notes are where the lecturer includes headings and leaves space for the student to add their own notes during the lecture.

Kenneth Kiewra suggested the idea of teaching notetaking for students, as 'left to their own devices [students] are terribly incomplete note takers, recording only about 30% of lecture ideas for future reference' (1985, p. 173). Over the years what was 'known' about notetaking became embedded into academic skills workshops for students and professional development programs for academics. To this day, a significant number of academics provide skeletal lecture slides on the basis that it encourages a more complete and therefore a more effective set of notes.

4. Discussion

The only problem is that what was *established* in these experiments did not always translate into the real world. Observational research, which examined what was happening in authentic classroom settings, came to some very different conclusions. In relation to skeletal lecture notes for example (and in far less prominent/cited research), James Hartley found that following 'a clear initial advantage for the incomplete hand-out group [after nine weeks the] difference was no longer statistically significant' (1976, p. 62). Even more disturbingly, Kiewra (who published extensively on student notetaking in the 1980s and 1990s) found that students who did not attend the lecture *at all*, but were given complete lecture notes, did better in test scores than students *who attended the lecture* but were given skeletal lecture notes. As mentioned, experimental research established that summarised (paraphrased) notes were more effective than transcribed notes (those written out as fully as possible). However, observational research which also included the revision/review process found that the opposite was true (Kobayashi, 2009). This area of research has since be further complicated by the discovery

that short-term memory capacity means that some students benefit more from transcribing, and others, more from paraphrased notes.

My own projects (Loughlin, 2015, 2017) looked at digitally mediated student notetaking . Although I took a phenomenological approach to my data collection, I realised during the analysis that it was becoming hypothetico-deductive because of the influence of research discovered during the literature review. I was expecting students using laptops to perform badly, having read articles which suggested that students who took lecture notes on a laptop were disadvantaged because of the amount of notes they could take compared to traditional note-takers (Van Schaack, 2009) and also because of their potential as a distraction (Kraushaar and Novak, 2010). Mueller and Oppenheimer’s (2014) experimental research found that students with laptops took more notes than those with a pen and paper but performed worse in tests, they suggested that this was because students were typing mindlessly, transcribing the content and thus, losing the encoding benefits of taking notes, throwing doubt again, on whether transcription or paraphrasing was more effective as a notetaking strategy.

My 2015 study of a large cohort of 200 students found no statistically significant difference between different notetaking media, in fact, those using laptops scored marginally higher on all tests than traditional note-takers. However, my main findings were that; firstly, the students took very few notes! This appears to be partly the result of lecture slides being made available before lectures and partly due to the revision/review strategy of individual students. Secondly, notetaking in lectures had assumed a disproportionate significance and was in fact, considerably less important to student strategies and learning outcomes than the revision/review process. However, the quantity and quality of notes taken during lectures and their relationship to academic success is highly contextually dependent, and the same students who took few notes in this series of lectures indicated that they behaved differently, contingent on the subject being taught and the approach of the lecturer.

Axial Coding - Mapping initial codes to ecosystem of academic practice

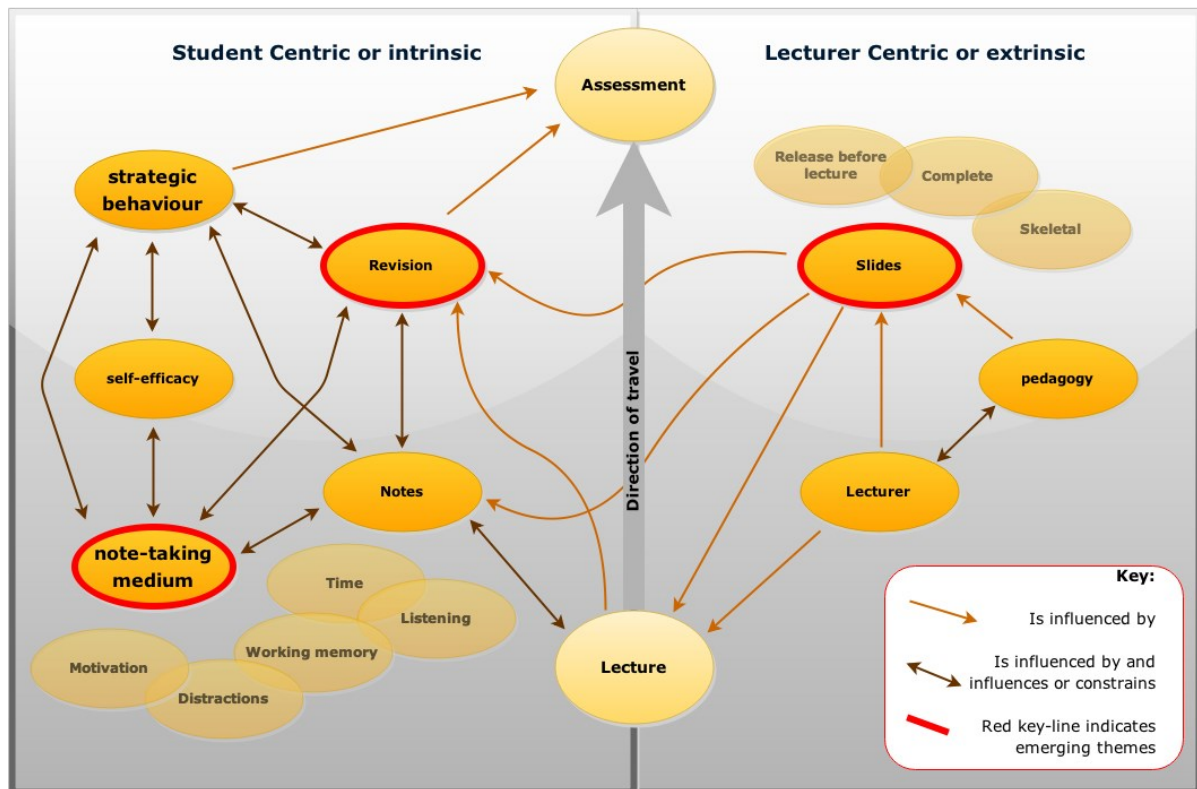


Figure 1: Axial Coding (Loughlin, 2015)

As can be seen in the diagram of the initial axial coding of the interviews for the study (Figure 1), even at a superficial level, there is a comparatively complex systemic relationship which influences the quantity and quality of notes taken during lectures. The attempts of experimental researchers to isolate notetaking behaviours led to outcomes which were misleading, and many of those behaviours and outcomes changed when real world influences were reintroduced. These contradictory findings highlight some of the problems associated with research into student notetaking. Students in a real-world setting are in lectures lasting two hours, or more,

and which generally form part of a lecture, seminar, self-study cycle; therefore, the students notetaking strategy could be very different. Ascribing causality of learning outcomes related to notes taken in a lecture is almost impossible, as the ideas would have been discussed in the seminar and revised before the test. Is learning said to have taken place when you can test for it after one week? nine weeks? or one year? While forcing students to take notes during lectures has been shown to improve short-term recall, it is much less conclusive when it comes to long-term conceptual understanding. The students disciplined enough to take comprehensive lecture notes are also likely to engage with the seminar and self-study/revision with equal vigour.

The data from a recent publication (Loughlin and Lindberg-Sand, 2022) - a mixed methods study of a lecture series in the health sciences with a cohort of 180 - again found that there was no statistically significant relationship between notetaking medium and exam results. While notetaking was not the primary focus of the study, we found that there was a weak correlation between notetaking quantity (self-reported) and the exam score ($r(96) = .078$, p value $<.01$) (see figure 2 – the width of the bars indicates the proportion of the sample in each box). Notetaking medium (iPad, Laptop or Pen) and the style of notes (from summarised to verbatim) had no statistically significant relationship with the exam scores.

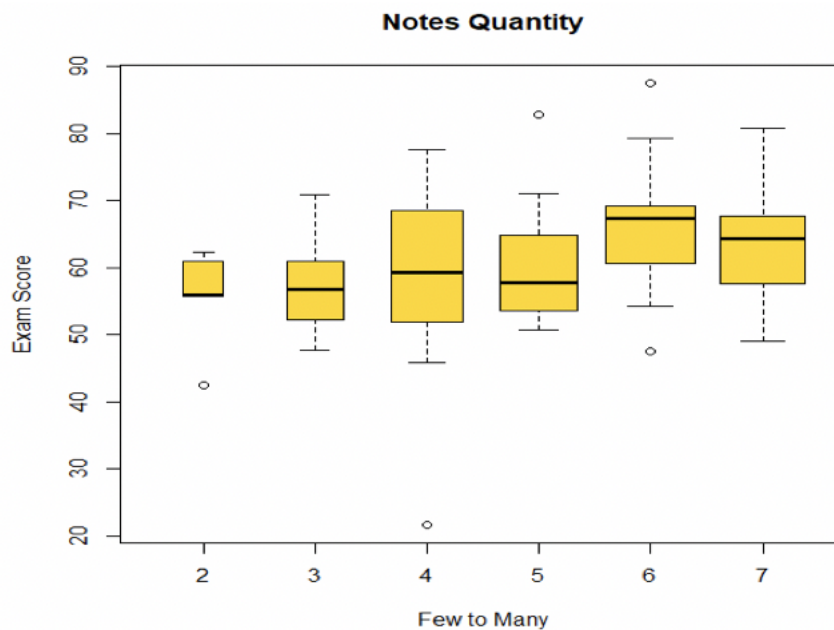


Figure 2

Thus (and contrary to several RCT trials), in three separate observational studies of a large-class lecture series (across two disciplines), laptop users outperformed pen users in the final exam, though not to a statistically significant degree.

4.1 Internal/External Validity

Munro (in Cartwright and Montuschi, 2014, p. 60) states that a 'study is said to have external validity when the "same intervention" has the "same result" as the RCT [randomised control trial] when used with a new population'. However, this measure of internal/external validity would fail to deal with some of the issues identified with the experimental research into notetaking by students, as the RCTs themselves would likely produce similar results in a similar RCT.

The experimental research into notetaking among students measured what it set out to measure, with methodology which would be replicable in different contexts. The problem with the research is that it controlled *out* some of the elements which are integral to notetaking in real world situations, such as, previous knowledge, motivation, personal strategies and preferences. While Cartwright and Hardie say that '[c]auses work in teams' (in Cartwright and Montuschi, 2014, p. 60) and describe a phenomenon of internally valid interventions failing in different contexts because one of the essential elements present in the experiment was missing in a different situation; they are describing the reverse of the experiments with student notetaking, where elements present in the real world were missing from the experiment. If one takes a broad definition of external validity as the ability to generalise the results into an everyday setting, then clearly some of these experimental studies would

fail. However, some experimental notetaking research has been taken at face value, and used to inform academic practice without reference to real world outcomes.

4.2 Auxiliary Hypotheses

Pierre Duhem introduced the idea of holist underdetermination in his 1914 book, *The Aim and Structure of Physical Theory*. The Stanford Encyclopaedia of Philosophy website describes holist underdetermination as the 'claim that theories or hypotheses can only be subjected to empirical testing in groups or collections, never in isolation' (Stanford, 2017). This appears to be a more promising description of the problems encountered with experimental notetaking research. They go on to say: 'The idea here is that a single scientific hypothesis does not by itself carry any implications about what we should expect to observe in nature; rather, we can derive empirical consequences from a hypothesis only when it is conjoined with many other beliefs and hypotheses' (ibid). Duhem, a physicist, was talking primarily about scientific underdetermination, but this was broadened to encompass 'all knowledge' by Willard Quine and appears to be particularly applicable to the social sciences.

Quine felt that, in addition to the underdetermination that Duhem outlined, that there is a psychological element, in which the researchers themselves, in the face of disconfirming evidence, choose which hypotheses to reject based on the simplicity or elegance of the solution, or even their own beliefs (Stanford, 2017). This can be seen in the work of Fried (2008) and Mueller and Oppenheimer (Mueller and Oppenheimer, 2014) who openly acknowledge a preference for handwritten notes, and use their results to draw conclusions about handwritten notes superiority over laptops, when a number of alternative explanations is equally likely.

Karl Popper (2008, p. 62) seems to imply that all auxiliary hypotheses are explicit and should add to the experimental fidelity, whereas, I would argue that, in the case of experimental notetaking research, the key auxiliary hypotheses remained implicit and unstated. There are many possible explanations for the discrepancy between the experimental research and its translation into real world situations. However, a good candidate is the auxiliary hypothesis that the quality of students' notetaking in lectures is causally responsible for the quality of their learning. It is not born out in observational research, and among many possibilities, it is just as likely that diligent students who are academically successful would produce good quality notes as a by-product of their diligence, rather than the good quality notes being a cause of their success. As John Stuart Mill points out, 'an hypothesis [...] is not to be received as probably true because it accounts for all the known phenomena' (ibid).

5. Conclusion

In attempting to demonstrate causality, researchers have been tempted into reductive experimental methodologies which have in some cases produced misleading results. In a social science context, attempting to describe complex systemic relationships can be further complicated by irrational and apparently random behaviour of individual subjects; for example, there is the game theory example where subjects choose options based on normative conditioning rather than logic (Cartwright and Montuschi, 2014). Cohen *et al* argue for 'establishing causation other than through reduction and recombination of atomistic, individual items and elements' (Cohen et al., 2011, p. 71) and contend that 'mixed methodologies and mixed methods [are more appropriate for] investigating and establishing causation' (ibid, p. 72).

Studies of students in higher education show that notetaking is influenced by such factors as, cognitive capacity; attitudes; motivation; the students' relationship with and regard for the lecturer; and the review process adopted by individual students. By reducing the notetaking event to a ten-minute, one-off session, experimental researchers can control for many factors but also eliminate the essence of what motivates students to take notes in the first place. With students 'only vaguely aware of accountability demands' (Van Meter et al., 1994, p. 332), and unable to relate the material in the lecture to previous knowledge, the experience becomes too abstract. Only by looking at the notetaking experience holistically in a real world setting and taking account of review and revision strategies can you begin to assess its impact.

In a meta-study, Kobayashi found that the 'overall effect of notetaking compared with no notetaking was positive but modest' (2009, p. 253); this, combined with Kiewra's finding that students who did not attend lectures but were given complete lecture notes could outperform those who attended, has shifted my focus from student notetaking to the Lecture itself. My own study found that the style, quantity and medium of notes taken during lectures, or even taking no notes at all, had no significant impact on learning outcomes, and that the review and revision process was considerably more important to students.

The use of experimental methodologies in relation to student notetaking in higher Education has highlighted a number of issues. Firstly, an internal/external validity problem, where some reductive RCT approaches have produced misleading outcomes. This has been compounded by some subsequent research relying on assumptions garnered from the flawed research as auxiliary hypotheses of their own. And secondly, the issue of implicit auxiliary hypotheses themselves. The RCT trials into student notetaking were trying to establish that particular techniques produced better notes, on the assumption that better quality lecture notes resulted in improved learning outcomes. The bigger question, of whether better notes were causally responsible for better learning outcomes has been subsequently answered with observational qualitative methodologies and renders many of the RCT studies moot.

Learning is a nebulous concept and measuring it not simply a matter of watching a litmus paper change colour. Personal psychology plays a significant role in learning outcomes and does not always lend itself to deductive experimental research techniques. While the balance of the evidence suggests that taking notes is beneficial to the learning process (probably on the basis that it helps with encoding), there is little to indicate that this should take place in the lecture hall, rather than as private study, or part of the revision and review process.

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