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Disfluency and Learning Outcomes: A Case of Malaysian Higher Education Institution

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Abstract
Purpose: The purpose of this study is to examine the effects of disfluency on student's performance in Malaysia.
Design/methodology/approach: A case study approach on undergraduate accounting students from Universiti Tenaga Nasional took part in this study.
Findings: A significant improvement in educational performance when students are being asked to learn from materials that were presented in challenging and difficult to read fonts (disfluent fonts) than from materials that were presented in easy to read fonts (fluent fonts).
Research limitations/implications: The outcome of this study is beneficial to educators in helping them formulate new guidelines and initiatives that will strengthen the existing learning methodology and thus help increase the number of quality graduates for the future. Moreover, this study also contributes to the research on disfluency.
Practical implications: Improving student's performance and the Malaysian educational system as a whole is one of the critical aspects of the National Blue Ocean Strategy.
Originality/value: This study contributes to the heterogeneous findings that disfluency is a desirable difficulty for learning. This study advocate that an effective learning approach is key for improving learning outcomes.
Paper type: Research paper

Keywords: Disfluency, Fluency, Higher institution learning, Memory, Performance assessment

Introduction

Fluency is the subjective experience of ease or difficulty, leading the learner to process information and concept. It is also considered one of the most prominent metacognitive signs used in reasoning. It is a feeling of ease associated with a cognitive operation that can be generated by nearly any form of thinking. For instance, if learning materials are phonemically irregular, it recognised the challenge in processing the information. In other words, people will know whether they have to struggle to memorise or have an easy time solving a puzzle. This is because cognitive processes generate a metacognitive experience of fluency whereby it is nearly effortless to access, and it can serve as a sign towards judgment in any situation.

On the other hand, disfluency is the subjective experience of difficulty associated with the cognitive operation and requires the learner to deeply process the information and challenge their mental task (Kühl & Eitel, 2016). For instance, people are more likely to increase their effort if task completion is perceived as disfluent, which helps activate analytic processing (Alter & Oppenheimer, 2008). Disfluency occurs in various nonfluencies conditions such as mispronouncing words and hesitations, self-repairs and editing terms, silent pauses, repetitions and fillers (Dayter, 2021). In other words, a disfluency is a form of desirable difficulty, can be produced merely by adopting fonts that are slightly more difficult to read and require deeper processing.

Modifying learning materials leads to cognitive challenges through deeper processing (İlic & Akbulut, 2019). Applying regular materials may limit the cognitive ability of learner in applying the skills that cannot be delegated to advanced devices (Alter, 2013). In the era of digital environment, cognitive bias appeared among the learner despite being the disciplinary expert and aware of the likelihood of cognitive bias (Bierema et al., 2020). The traditional method of teaching the learners heavily relies on the experience and instinct of educators (Book et al., 1983). Empirical studies (Bjork, 2004; Diemand-Yauman et al., 2011; Sweller & Chandler, 1994) found that the instinct learning's style was detrimental to learners performance. Similarly, education scholars (Sweller & Chandler, 1994) posit that reducing unimportant cognitive matters is also beneficial for the learners. The learning activities is considered as success when the learner understand of new lesson, regardless the process to relearn the those activities.

On the other hand, having better cognitive engagement from the instructor leads to deeper processing by the student (Craik & Tulving, 1975). In other words, it will help the students have better retrieval of the lesson later. Previous studies found that subjective experience of difficulty is associated with cognitive operations (Desender et al., 2017). Thus, disfluency in learning materials may lead to a better learning performance by encouraging deeper processing resulting in better memory performance. The more complex the information given in the learning materials, the higher the level of working memory that will be used.

Despite educational research claimed that difficult learning conditions – learning disfluent, hard to read learning materials improved learning performance, the findings have been inconsistent (İlic & Akbulut, 2019; Weissgerber, 2017). It is advisable, the learner to avoid learning materials with disfluent text. However, Diemand-Yauman et al. (2011) claimed that learning outcome was enhanced with hard to read and less fluent learning materials. These difficulties seem desirable since the students may overcome their challenge in retrieving the information in the learning materials. Therefore, working memory plays a vital role to determine whether disfluency improves or hinders learning. Paas et al. (1994) posit that individual learners are aware of their cognitive level, thus subjective norms are considered as useful to measure mental effort. Taken together, does the style of learning materials by educators influence the level of educational performance of learners?

Therefore, this educational study aims to examine the effects of disfluency on educational performance. Specifically, this study attempts to investigate whether the style of learning material, as measured by disfluency font and fluency font, influences the level of learners educational outcomes. This paper is arranged as follows; the next section is a discussion on previous studies on disfluency and fluency, the next section discussion on the sample used in this study and research design. The last section elaborates on the result obtained and discussion on the findings, suggestions and future research agenda.

Literature Review

Diemand-Yauman et al. (2011) found that the student retention of material across a wide range of subjects and difficulty levels was significantly improved in naturalistic settings by presenting reading material in a slightly harder format to read. Richland et al. (2005) found that leaner deeper processing required on cognitive load was contributed to higher working memory as this process requiring the learner to generate rather than passively consume all information with easier to read. Further, Hirshman & Bjork (1988) posit that encouraging learners to generate letters in a word pair during memorisation resulted in a higher retention rate than their counterparts. Similarly, Richland et al. (2005) found a significant positive result which suggested that the student in the classroom environment had also demonstrated better memory performance. Therefore, it is worthy to note that the intervention engages processes that support

the learning experience is perceived as the main element towards improvement in learning performance and not only the difficulty of the information given.

Furthermore, disfluency also could lead to the improvement of classroom performance. For instance, Alter et al. (2007) conducted a study on classroom performance and found that disfluency also encouraging effective learning in the classroom whereby it leads people to process the information received more deeply, more abstractly and more carefully, which results to better comprehension (Alter & Oppenheimer, 2008). Moreover, disfluency is also perceived as a cue to those who have no mastery over learning materials (Alter & Oppenheimer, 2009) as considered as less confident in how well they have learned the material and engage more effort and elaborative processing style (Castel et al., 2007). Advanced learning materials through digital devices create contemporary opportunities and facilitate the learners in carrying out many activities (İlic & Akbulut, 2019).

However, investigation of the role of disfluency through fluent and disfluent text and animation suggested that materials with disfluent animation and disfluent text could reduce the learning outcome (İlic & Akbulut, 2019). Taken together, this study expected that the learners with hard to read fonts will be able to remember better than learners with easier to read fonts. Thus, I proposed the following hypotheses:

H1 *Disfluency significantly improves the memory performance of learners.*

H2 *Fluency significantly inhibits the memory performance of learners.*

Methods

Sample Selection

The sample of this study comprises year-3 undergraduate accounting students in Universiti Tenaga Nasional, Pahang, Malaysia. The student who took the internal auditing course was recruited as respondents and not possess subjective knowledge of the course. It is worth noting that this study selected those students who are currently taking internal auditing courses at the first time and assumed that they have no prior knowledge of the subject matter. The exact number of students registered for the course was obtained through the university portal. There are one hundred six students currently taking the required course. In order to avoid sampling bias, simple random sampling was applied, leading to fifty-five students taking part in this study, ages ranged from 19-21 years old. They were divided into two sections; section one consists of twenty-five students, and section two is thirty students.

Materials, Procedure and Design

The objective is to examine the effect of disfluency on learners educational performance. This evaluation is also aligned with the bloom taxonomy recommended for the course. Based on overall performance on the latest student's Cumulative Grade Point Average (CGPA) results, students from sections one and two have been assigned to disfluent and fluent categories, respectively. Accordingly, a set of learning materials about the course was prepared and made available to both sections and distributed in the classroom. In the control condition strategy (Diemand-Yauman et al., 2011), the actual contents of learning materials are similar and unedited for both categories. Learning materials were presented in 12-point Vivaldi with 1.15 spacing in greyscale font in the disfluent condition. As for fluent condition, learning materials was presented in 12-point Tahoma with 1.5 spacing in pure black font. They are required to memorise the contents of learning material to be tested. Figure 1 shows the disfluent font in the top panel and the fluent font at the bottom panel used in this study.

The Keywords	Fundamental phases
• Independence and Objectivity • Assurance and Consulting services • Add value • Systematic and disciplined approach • Risk Management, Control and Governance	• Planning the engagement • Performing the engagement • Communicating engagement outcomes

Figure 1: Disfluent and Fluent Fonts

Findings

This study attempts to examine the effects of disfluency on students' performance. The result was generalised into actual classroom environment. Based on learning materials designed for both disfluent and fluent types, a test was conducted to examine their outcomes. Both sections, disfluent and fluent, were successfully answered 100% of the questions within 45 minutes. Test was conducted and the result was extracted and converted to *Z*-scores as a mechanism to compare their performance. The Z-score was calculated across different sections of the same course. Based on the score, the section from the disfluent condition scored higher on classroom assessments with mean score ($M = 17.72$, $SD = 2.38$). The mean value for fluent, $M = 15.92$ and Standard Deviation, $SD = 3.82$. This study also employed an independent sample t-test to reveal the differences between disfluent type and fluent type of font on student's performance. The result shows statistically significant with the scores of $t = 2.015$, $p < 0.005$.

Table 1: Average *Z*-Scores for Disfluent and Fluent across the Categories

Course	Disfluent	Fluent
Internal Auditing	4.84	1.55

Note that the Z-scores do not sum to 0 across conditions because of unequal sample sizes by condition.

In summary, there are reliable retention differences between students exposed to the different font types of disfluent and fluent. This study confirmed that the disfluency type improves student's performance. The result was also consistent with Richland et al. (2005). Overall, disfluent font type motivates the learner to think deeply, which resulting better memory performance. Furthermore, font with difficulty to read encourages them to struggle, indicating that working memory works harder and results in better performance from their counterparts. This study proves that simple changes in font size and type of learning materials significantly improve student performance. It is concluded that cognitive interventions have the potential to improve educational outcomes among students continuously.

Discussion and Conclusion

The effect of disfluency is manipulated Alter et al. (2007) posited that disfluency appears as a desirable difficulty that leading deeper processing strategies. Disfluency was driven by a surface feature accepted by the reader and had nothing to do with semantic processing. The semantic processing will lead the student to process deeply all the information that was perceived. Disfluency also were driven by distinctiveness of leaners (Diemand-Yauman et al., 2011). In summary, disfluency and fluency learning materials significantly contributes to student cognitive educational interventions which in turn influence their educational performance.

Despite the benefits received from the disfluent type of font, some limitations of the disfluent type should be regarded.

On the other hand, fluency is regarded as someone ability to read with accurate and proper expression. Fluency also can be manipulated through designed material to the student. One of the ways educators can do this is by manipulating the font size. However, Diemand-Yauman et al. (2011) emphasise that someone's memory does not differ as a font size function. Thus, it may be influenced by other factors that might contribute to the desirable of difficulties. The nature of the materials (McDaniel et al., 2002) and how students were tested (Thomas & McDaniel, 2007) can be other factors for student performance.

Moreover, fluency interventions can be integrated into an electronic version of learning materials to the students. Coupled with effective pedagogy used in the classroom, fluency interventions are classified as cost-effectiveness and may not require curriculum reform or interfere with teaching styles (Diemand-Yauman et al., 2011).

Theoretical Implications

Theoretically, disfluent learning materials is considered difficult to read and understand by students. This condition may create demotivation or motivational barriers among the student which is they might become frustrated to read or perhaps ignore it, rather stay focused to read all those important information. For instance, Reber et al. (1998) found that disfluency may cause students exhausted to read further the learning materials.

Practical and Social Implications

In a practical and social perspective, disfluency may enhance the practical interventions between the educators and students for performance improvement.

Limitations and Suggestions for Future Research

Future research on disfluency may incorporate with differentiating assessment and memory performance of the students. Expanding into a qualitative approach on disfluency may be an interesting for future research agenda. Lastly, future research on implementing disfluency intervention might be useful and gain more insightful meaning on educational outcomes.

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