



# Examining Metacognitive Awareness As A Mediating Factor In The Relationship Between Screen Time And Cognitive Failures Among Online Learners

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**Abstract:** The growing use of digital technology in education has considerably increased the usage of online learning platforms, resulting in higher amounts of daily screen exposure. While digital learning is convenient and flexible, concerns have been raised about its possible impact on cognitive functioning. The current study sought to investigate the association between screen time and cognitive failures among online learners, as well as the function of metacognitive awareness in that relationship. Specifically, the study looked into whether metacognitive awareness mediates the link between screen time and ordinary cognitive failures. A quantitative correlational research methodology was used, with data collected from 147 online learners via standardized self-report measures assessing screen time, metacognitive awareness, and cognitive failures. Statistical descriptive measures and analyses — including correlation tests and mediation analysis — were used to explore how the variables interacted together.

Reviewing the findings as a whole, it was determined that there is a direct correlation between screen time and cognitive impairments. In other words, if people spend more time using screens, their probability of experiencing cognitive failures will increase. In addition, screen time has a positive correlation to metacognitive awareness. Thus, it can be reasonably assumed that using screens to engage in learning (through digital learning environments) will improve participants' metacognitive awareness. However, there is no statistically significant correlation between metacognitive awareness and cognitive impairment. Mediation Analysis has indicated that an awareness of metacognitive processes alone does not eliminate the relationship between the amount of time spent on screens and cognitive performance. Therefore, while learners may understand how they learn, this understanding cannot negate the negative consequences of excessive screen use on cognitive performance.

In conclusion, this study adds to the existing literature examining the effects of screen use on cognitive functioning and investigating the relationship between cognitive failures and screen use. Hence, in order to avoid cognitive interference while using the internet for learning, students must learn to develop skills of good screen use along with metacognitive skills.

**Index Terms** - Screen time, cognitive failures, metacognitive awareness, online learners, digital learning, cognitive functioning.

## I. INTRODUCTION

Significantly, the increased digitalization of learning has impacted learning environments worldwide. For example, the increased availability of online learning platforms, particularly during the COVID-19 pandemic, has increased the dependency of students on digital media for learning (Dhawan, 2020). Learning through online platforms involves increased screen time for students using laptops, smartphones, and tablets for longer periods. Although digital media has increased learning accessibility and flexibility, research has shown that increased screen time has adverse effects on the cognitive abilities, attention management, and self-regulatory skills of learners (Cain & Gradisar, 2010; Wilmer et al., 2017).

The "screen time" has been defined as the time spent viewing digital screens, which include computers, smartphones, tablets, and TVs (Twenge & Campbell, 2018). Excessive "screen time" for multitasking activities through digital devices has been observed to lead to cognitive deficits, mental fatigue, and issues of executive control (Ophir et al., 2009). These cognitive deficits include minor impairments in perception, memory, and behavioral aspects (Broadbent et al., 1982).

According to Broadbent et al. (1982), cognitive failures are defined as failures in attention, memory, and physical performance that individuals experience in their daily lives. Some examples of cognitive failures include forgetting appointments, forgetting things, and forgetting important signals. Cognitive failures do not necessarily imply that a person is not intelligent, as cognitive failures are often linked to issues such as attention control, stress, and cognitive overload (Reason, 1990). The excessive use of digital media switchability, the nature of notifications in digital media, and the need to use multiple media for online learners may cause cognitive overload, which may cause cognitive failures.

Another psychological factor of importance is metacognitive awareness. This is a critical factor in the given relationship. It has been described as "thinking about thinking," which entails the awareness of cognitive processes as well as the regulation of the processes (Flavell, 1979). It entails two dimensions: metacognitive knowledge and metacognitive regulation. The former entails the awareness of strategies, tasks, and the self, while the latter entails planning, monitoring, and assessing oneself (Schraw & Dennison, 1994). It is of critical importance in the minimization of distractions, the concentration of attention, and the improvement of cognitive performance, especially in an online environment (Azevedo & Cromley, 2004).

The main objective of this particular study was to examine the role of metacognitive awareness in the relationship between screen time and cognitive slips of online learners. More specifically, this study sought to examine whether or not metacognitive awareness could be considered as a mediating or moderating variable that buffers or accounts for the relationship between screen time and ordinary cognitive slips.

### 1.1 Conceptual Understanding

#### 1.1.1 Screen Time

The total time spent on screens for socializing, academic, and leisure-related activities is known as screen time. As per research, excessive screen time has been linked with lower cognitive efficiency, sleep problems, and attentional fragmentation. A decrease in working memory and attention filtering capabilities was observed as a consequence of excessive media multitasking. Social media and academic screen time may often overlap for online students.

#### 1.1.2 Cognitive Failures

Cognitive failures were defined by Broadbent et al. (1982) as little errors in perception, memory, and motor function that occur during daily tasks. Stress levels, ambient distractions, and attentional control all have an impact on these lapses (Reason, 1990). According to the Cognitive Load Theory (Sweller, 1988), too many outside stimuli may be too much for working memory, which could lead to more mistakes and performance lapses.

### 1.1.3 Metacognitive Awareness

Metacognition is a higher-order cognitive process that involves awareness and control of one's own thoughts, according to Flavell (1979). Additionally, Schraw and Dennison (1994) distinguished metacognitive awareness into:

1. Declarative, procedural, and conditional knowledge are examples of metacognitive knowledge.
2. Metacognitive Regulation: Strategies for planning, observing, and assessing.

Zimmerman (2002) highlighted the importance of metacognition in self-regulated learning. Higher levels of metacognitive awareness help online learners better control their digital engagement, manage distractions, and allocate their attention.

## 1.2 Theoretical Framework

### 1. The theory of cognitive load (Sweller, 1988)

According to the cognitive load theory, working memory has a finite amount of capacity. Overuse of screens when multitasking can lead to an increase in extraneous cognitive load, which can cause attention problems and cognitive impairments. Online learners who are always switching between apps and notifications may become overwhelmed and make mistakes.

### 2. The theory of self-regulated learning (Zimmerman, 2002)

Active planning, observation, and evaluation of one's learning processes are all components of self-regulated learning. A fundamental element of this approach is metacognitive awareness. Stronger self-control makes learners more capable of handling screen distractions.

### 3. The Theory of Attentional Control (Eysenck et al., 2007)

According to Attentional Control Theory, attentional control processes are hampered by worry and external distractions. Multitasking and digital alerts may decrease goal-directed attention, which would increase cognitive failures.

### 4. Flavell (1979) developed the metacognitive theory.

According to the view of Flavell, people are capable of controlling the focus of their attention and the methods of remembering by becoming aware of the mental processes. The harmful cognitive impacts of excessive screen time can be controlled by high metacognitive awareness.

## 1.3 Rationale

It is essential to consider the cognitive effects of excessive exposure to screens since there is an increasing reliance on digital mediums for educational purposes. It is possible for metacognitive awareness to reduce the effects of excessive exposure to screens on cognitive failures. The researching of this association will enlighten the strategies used to enhance self-control among learners using digital mediums.

However, most studies have focused on either the direct effects of digital exposure or the facilitating role of metacognitive awareness in self-regulation and performance. Few studies have examined these three factors as a whole or the role of metacognitive awareness as a mediator in the relationship between screen time and cognitive failures, especially in online learning. Moreover, there is a lack of mediation-based evidence in new digital learning environments. This study will address this issue by exploring the relationships among screen time, metacognitive awareness, and cognitive failures, as well as the role of metacognitive awareness as a mediator in online learning.

## 1.4 Objectives

1. To explore the connection between online learners' screen time and cognitive failures.
2. To evaluate how screen time and metacognitive awareness are associated.
3. To evaluate how metacognitive awareness and cognitive failures are related.

4. To investigate how screen time and cognitive failures are related to metacognitive awareness.

### 1.5 Research Questions

1. What is the relationship between screen usage and cognitive impairment due to online education?
2. Are there associations between online students' screen time and their metacognitive awareness of their thought processes?
3. Do online learners exhibit cognitive deficits in relation to their metacognitive awareness?
4. Can metacognitive awareness moderate the effect of screen usage on cognitive deficits of online learners?

### 1.6 Hypotheses

H1: Among online learners, screen time and cognitive failures will be significantly correlated.

H2: Among online learners, screen time and metacognitive awareness will be significantly correlated.

H3: Among online learners, metacognitive awareness and cognitive failures will be significantly correlated.

H4: The association between screen time and cognitive failures in online learners will be considerably mediated or moderated by metacognitive awareness.

## II. METHODOLOGY

### 2.1 Research Design

The current study uses a quantitative, non-experimental, cross-sectional correlational research design. A correlational design is excellent for investigating correlations between psychological factors without manipulating them (Creswell & Creswell, 2018). Because screen time, metacognitive awareness, and cognitive errors occur spontaneously in learners, experimental control was neither possible nor necessary.

The study also includes predictive and mediation analyses, which allow for an investigation of the explanatory role of metacognitive awareness in the relationship between screen exposure and cognitive failures.

### 2.2 Population

The study's population consists of online learners enrolled in higher education institutions, including undergraduate and postgraduate students who frequently use digital or online learning platforms.

Online learners were chosen because digital learning environments necessitate extended screen time and improved self-regulated learning abilities (Dhawan, 2020).

### 2.3 Sample and Sampling Technique

#### 2.3.1 Sample

The target population is online learners who are between the ages of 18 and 25. This population is focused on because they are in higher learning and are using online learning as a means of acquiring knowledge.

#### 2.3.2 Sampling Technique

The researchers used a non-probability sampling method, which is the convenience sampling method. This method is used because it is easy and possible to access the population of interest online. This

method is also applicable in behavioral studies and education, especially when the target population is students (Etikan et al., 2016).

The inclusion criteria for the participants were:

- Regular online learning
- Use of digital screens daily for learning
- Consent to participate

## 2.4 Research Tools

As part of a previous study, established psychological scales that measure for how long online students are looking at screens, how often they have a cognitive slip, and how much their thoughts influence them were used. The reason for using the above-described scales was because of their use overall and the validity and reliability of each of the scales. The following is a detailed explanation of the assessment measures that were used in the study.

### 2.4.1 Screentime Questionnaire

To estimate the amount of time people spend daily using digital devices such as phones, laptops, tablets, and computers, a structured self-report Screen Time Questionnaire was used. It measured the amount of time people are exposed to screens for study, social, and leisure purposes.

Self-reported screen exposure is one of the most popular methods in the field of behavioral and media psychology because it is easy to collect on a large scale. Research on digital behavior and the psychological effects of technology has repeatedly used self-reported screen exposure as a reliable method of determining the extent of individuals' involvement in technology (Jean M. Twenge & W. Keith Campbell, 2018).

Evidence demonstrates that self-reported screen time questionnaires have acceptable test-retest reliability, with correlation coefficients ranging from  $r = .70$  to  $.85$ , indicating that responses remain stable over time. Convergent validity has also been substantiated by moderate correlations between self-reported screen use and objectively logged digital usage data from media-use studies. As a result, such metrics are deemed appropriate for quantifying behavioral exposure in educational and psychological research.

### 2.4.2 Cognitive Failure Questionnaire (CFQ)

The Cognitive Failures Questionnaire (CFQ), developed by Donald E. Broadbent, Peter F. Cooper, Paul FitzGerald, and Katherine R. Parkes in 1982, was used to assess cognitive failures. The CFQ is a commonly used self-report measure for determining the frequency of cognitive lapses in everyday life circumstances.

The questionnaire assesses three major areas of cognitive functioning: attention deficits, memory lapses, and action execution problems. Items examine frequent cognitive errors such as forgetting appointments, losing concentration during tasks, or acting unintentionally. Participants react according to how frequently such failures occur in their everyday tasks.

The CFQ has shown robust psychometrics for different populations, including college students and adults. Broadbent and colleagues (1982) found that the CFQ has high internal consistency, where the Cronbach's alpha was found to be approximately 0.89, and test-retest reliability was found to be between 0.78 and 0.82. Construct validity is also evident through the correlations found between attention control, stress, fatigue, and cognitive performance, which confirms the utility of the CFQ for measuring daily cognitive functioning. Based on its robustness and substantial research support, the CFQ is considered an effective and reliable means of measuring cognitive slips within educational research contexts.

### 2.4.3 Metacognitive Awareness Inventory(MAI)

The Metacognitive Awareness Inventory, abbreviated as MAI, is an instrument meant for measuring the extent of an individual's knowledge about his or her own thoughts. To put it simply, it is meant for measuring the extent of an individual's awareness of the processes occurring within his or her mind. It was developed by Gregory Schraw and Rayne S. Dennison all the way back in 1994.

Regarding metacognition, the MAI has two aspects:

- Metacognitive knowledge, which relates to what an individual knows about his or her thoughts, including his or her cognitive abilities and the techniques he or she should apply for effective completion of the task at hand.
- Metacognitive regulation, which relates to the manner in which an individual plans his or her learning techniques, including his or her decisions on the techniques he or she should apply for the task at hand.

Lastly, it has an aspect concerning self-regulated learning, which is of great importance in the virtual world.

Apparently, the tool has a good level of psychometric strength. Schraw & Dennison (1994) found the measure to have high internal consistency, as indicated by Cronbach alpha coefficients ranging from 0.90 to 0.95 for the entire scale, as well as high reliability for its subscales. Recent research on education has also supported the construct validity, factorial stability, and usefulness of the measure for both adolescent and adult learners. The MAI also correlates positively with academic achievement, self-regulated learning, and problem-solving ability, thus supporting its validity as a measure of metacognitive capacity.

### 2.5 Procedure for data collection

Data was gathered by administering surveys online using digital tools like Google Forms. The process entailed:

- Creating an online survey with informed permission.
- Links to the survey are shared via online learning communities and academic groups.
- The goal of the study, confidentiality, and voluntary involvement were explained to the participants.
- Anonymous responses were gathered.
- Before being analyzed, completed replies were checked for completeness.

In research involving digital learners, online data collecting guarantees efficiency

### 2.6 Methods of Data Analysis

The statistical program Jamovi and SPSS was used to analyze the data.

The statistical analyses listed below were carried out:

- Standard Deviation and Mean in Descriptive Statistics
- Pearson Correlation Analysis
- Mediation Analysis

While mediation analysis looks at indirect impacts between predictor and result factors, correlation analysis establishes links between variables (Hayes, 2018).

At the  $p < .05$  level, statistical significance was examined.

### III.RESULTS

**Table 3.1**

Descriptive Statistics For Study Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
TST	147	1	24	4.64	2.442
TMAI	147	19	38	23.30	2.613
TCFQ	147	0	100	46.14	15.960

The descriptive statistics of Cognitive Failures (TCFQ), Metacognitive Awareness (TMAI), and Total Screen Time (TST) among online learners (N = 147) are shown in Table 1. The average screen time, metacognitive awareness, and cognitive failures reported by the participants were M = 4.64 (SD = 2.44), M = 23.30 (SD = 2.61), and M = 46.14 (SD = 15.96). Suitability for additional correlational and inferential analysis is indicated by the variability seen across variables.

**Table 3.2**

Correlations for Study Variables

Variable		TST	TMAI	TCFQ
TST	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	147		
TMAI	Pearson Correlation	.249**	1	
	Sig. (2-tailed)	.002		
	N	147		
TCFQ	Pearson Correlation	.224**	.108	1
	Sig. (2-tailed)	.006	.195	
	N	147		

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Screen time was significantly positively correlated with both metacognitive awareness ( $r = .249$ ,  $p = .002$ ) and cognitive failures ( $r = .224$ ,  $p = .006$ ), according to Pearson correlation analysis. Nevertheless, there was no significant correlation between metacognitive awareness and cognitive failures ( $r = .108$ ,  $p = .195$ ).

**Table 3.3**

Mediation Estimates

Effect	Label	Estimate	SE	95% Confidence Interval		Z	p
				Lower	Upper		
Indirect	a x b	0.0897	0.219	-0.343	0.619	0.410	0.682
Direct	c	1.3774	0.630	0.170	2.673	2.185	0.029
Total	c+a x b	1.4671	0.568	0.292	2.617	2.583	0.010

The indirect effect of screen time on cognitive failures through metacognitive awareness was non-significant ( $\beta = 0.0897$ ,  $p = .682$ ). On the other hand, screen time had a substantial direct impact on cognitive failures ( $\beta = 1.3774$ ,  $p = .029$ ). Additionally, the overall effect was significant ( $\beta = 1.4671$ ,  $p = .010$ ), indicating that screen time is an independent predictor of cognitive failures in online learners.

#### IV. DISCUSSION

The aim of the study was to investigate the relationship between screen time and cognitive failures in online learners, as well as the role of metacognitive awareness in that relationship. The results are discussed in relation to the hypotheses and theories.

The descriptive study showed that on average, individuals spend a moderate amount of time with screens and have differing levels of metacognitive awareness, as well as differing cognitive failures. This suggests that there are definitely differences in individuals' screen time, metacognitive awareness, and cognitive failures. This is in line with the Cognitive Load Theory (Sweller, 1988), which suggests that too much information can lead to information overload in the working memory.

Based on the results of the study, there is a significant positive correlation between using screens and experiencing cognitive failures ( $r = .224, p < .01$ ), which supports our first hypothesis. In other words, the more time someone spends engaged with a digital screen, the more they will experience cognitive failures or lapses in attention (i.e., forgetting what they were doing), which leads to "fragmentation of attention" and also reduces cognitive efficiency. The positive correlation between these two variables is expected and consistent with previous research indicating prolonged screen use and multitasking create limitations on attention management and executive function performance. Therefore it can be concluded that excessive screen time contributes to cognitive failure for online learners as supported by hypothesis 1.

The study revealed a significant positive correlation ( $r = .249, p < .01$ ) between metacognitive awareness and screen time, which supports Hypothesis 2. This is indicative of learners reporting a greater amount of screen time also having marginally higher levels of use of metacognitive strategies. This could be related to the independent nature of the online learning environment where students are expected to be self-motivated and regulate, monitor, and evaluate their own learning. According to Zimmerman's Self-Regulated Learning Theory (2002), the independence required in digital learning environments may assist in developing metacognitive skills. Therefore, Hypothesis 2 has been supported.

Hypothesis 3 posited a strong association between cognitive failures and metacognitive awareness; however, this hypothesis was not supported because the relationship between the two was found to be statistically insignificant ( $r = .108; p > .05$ ). This study suggests that although simply having metacognitive awareness will not necessarily reduce or minimize the effect of cognitive failure when learning in an online environment, metacognitive skills can allow for better monitoring of cognitive processing (i.e. metacognitive awareness helps individuals monitor & regulate cognitive processing; Flavell, 1979). Therefore, there is no significant correlation between having metacognitive awareness and managing behaviour when faced with high levels of digital distractions; rather, external factors (e.g. technical demands of the learning environment) may play a more significant role in impacting the development of self-regulation than could be attributed to the individual's capacity to create a self-regulatory style of dealing with distractions.

In the mediation analysis, it was examined if metacognitive awareness could play a role as a mediator between screen time and cognitive impairments. However, it was found that the indirect effect was non-significant; screen time was found to have a significant direct effect on cognitive failures ( $p < .05$ ), but the overall effect was significant ( $p < .01$ ). In other words, metacognitive awareness was not found to play any role as a mediator. Thus, screen time has been found to have a direct effect on cognitive failures, rather than an indirect effect through metacognition. This is in line with Attentional Control Theory (Eysenck et al., 2007), which argues that even when an individual is aware of cognitive strategies, their attentional efficiency can be hindered by environmental factors, including distractions.

The findings suggest that it is possible for online learners to become aware of the workings of their mind, but it is still true that "too much screen time remains a direct threat to attention and memory." This again emphasizes the need for interventions that not only inform but also enable learners to manage their screen time so that they are not subjected to cognitive overload.

## 4.1 Limitations of the study

- **Cross-sectional study limitations:-** Since we are examining one specific point in time, we cannot definitively say that screen time causes changes in metacognitive awareness or cognitive mistakes.
- **Self-report bias:-** Since we are depending on the self-report of the participants, we may face issues with bias and errors, especially with regard to measuring their screen time.
- **Limited generalizability:-** The study sample included only online learners from a specific demography, limiting the findings' application to other groups.
- **Subjective Screen Time Assessment:-** Screen exposure was assessed using self-reported estimates rather than objective digital tracking methods.
- **Uncontrolled Extraneous Variables:-** Factors such as the level of stress, the quality of sleep, and the propensity for multitasking were not controlled, and these factors could have contributed to a greater number of cognitive slips.

## 4.2 Recommendations

Some suggestions for schools, students, and further research can be drawn from what was found in the current study. For instance, as the current study found a correlation between increased screen time and more cognitive slips, schools should ensure that there is a healthy use of screen time for online students. Training programs for students to ensure the development of good metacognitive skills can also be beneficial for the student to be more aware of the learning habits and the ability to cope with distractions from the use of technology for learning.

Teachers should focus on the productive and purposeful use of screens rather than multitasking. Multitasking can lead to attention slips. Schools can provide students with training on how to be aware of managing their attention, time, and developing healthy screen habits.

## V. CONCLUSION

This research explored the amount of time spent in front of a screen by online learners and the connection to cognitive slips or errors, specifically metacognitive awareness. The importance of the research lies in the fact that the expansion of digital learning is taking place at a very rapid rate, and the influence of screens on cognitive performance is a vital area of concern. The research provides extensive insights into the influence of tech-based education.

The study has also indicated the relationship between the amount of time spent viewing screens and cognitive slips. To summarize, excessive viewing of screens has the potential to drain the attention, memory, and information processing capacity of the individual, especially during the learning process through the internet. When the digital learning environment presents multitasking challenges, information overload, and interruptions, the individual is likely to face cognitive challenges. However, the flip side of the coin is that excessive viewing of screens has also been indicated to have a positive relationship with metacognitive awareness. Learning through the internet has the potential to improve the individual's metacognitive awareness, depending on the amount of freedom they have to do the learning.

Metacognitive awareness is also not related to fewer cognitive slip-ups, nor does it alter the relationship between screen time and cognitive slip-ups. The short answer is that even though students may be aware of what they're doing, even though they may be metacognitively aware of their own thinking, it doesn't

appear that this awareness is enough to protect them from the cognitive consequences of spending so much time in front of screens. The relationship between screen time and cognitive slip-ups appears more direct, perhaps because of the cognitive overload and attentional breaks that screen environments impose.

This, in turn, accentuates the importance of striking the right balance in the screen time of the online learners, along with the need to develop strong skills in terms of self-regulation and concentration. The study suggests the importance of educational policies to encourage healthy engagement among learners in terms of the digital medium, to ensure the advancement of technology is not detrimental to the cognitive abilities of the learners.

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## REFERENCES

1. Azevedo, R., & Cromley, J. G. (2004). Does training on self-regulated learning facilitate students' learning with hypermedia? *Journal of Educational Psychology*, 96(3), 523–535.
2. Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, 21(1), 1–16.
3. Cain, N., & Gradisar, M. (2010). Electronic media use and sleep in school-aged children and adolescents: A review. *Sleep Medicine*, 11(8), 735–742.
4. Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5–22.
5. Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion*, 7(2), 336–353.
6. Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, 34(10), 906–911.
7. Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, 106(37), 15583–15587.
8. Reason, J. (1990). *Human error*. Cambridge University Press.
9. Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology*, 19(4), 460–475.
10. Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285.
11. Twenge, J. M., & Campbell, W. K. (2018). Associations between screen time and lower psychological well-being among children and adolescents. *Preventive Medicine Reports*, 12, 271–283.

12. Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, 41(2), 64–70.

