The Qualitative Report

Volume 22 | Number 7 Article 18

7-30-2017

"You Can Sort of Feel It": Exploring Metacognition and the Feeling of Knowing Among Undergraduate Students

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Recommended APA Citation

Gutierrez de Blume, A. P., Wells, P., Davis, C., & Parker, J. (2017). "You Can Sort of Feel It": Exploring Metacognition and the Feeling of Knowing Among Undergraduate Students. *The Qualitative Report*, *22*(7), 2017-2032. https://doi.org/10.46743/2160-3715/2017.2802

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Abstract

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Keywords

Feeling of Knowing, Qualitative Method, Interviews, Undergraduate Students, Comprehension Monitoring, Self-Regulated Learning

The Qualitative Report 2017 Volume 22, Number 7, Article 14, 2016-2032

"You Can Sort of Feel It": Exploring Metacognition and the Feeling of Knowing Among Undergraduate Students

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Traditional research on the metacognitive practice of calibration has been primarily investigated within the realm of quantitative experimental methodologies. This article expands the research scope of metacognitive calibration by offering a qualitative approach to the growing body of literature. More specifically, the current study investigates the learners' perspective on the calibration process. Ten undergraduate students were selected to participate in a structured interview on their previous calibration performances (five students low in calibration processing and five proficient in calibration processing). Ultimately nine students (N=9) participated in individual interviews. Participant interviews are qualitatively assessed through the mediums of (1) Serra and Matcalfe's original work on the "feelings of knowing" and (2) self-regulated learning theory (SRL). Results indicate a difference in feelings of knowing between low and proficient calibrators across a battery of themes: effort, strategies, planning, and evaluation. Implications of the results and direction for future research are explored. Keywords: Feeling of Knowing, Qualitative Method, Interviews, Undergraduate Students, Comprehension Monitoring, Self-Regulated Learning

Have you ever taken a test and felt certain that you aced it? Or perhaps you knew you did not do your best? Although unaware, you were practicing the metacognitive process of calibration. Calibration, what we refer to as a *feeling of knowing* (Serra & Metcalfe, 2009), a process that expresses learners' ability to monitor their comprehension (Glenberg & Epstein, 1985), has traditionally been examined in a quantitative paradigm, as evidenced by the extant literature that predominantly uses experimental or quasi-experimental designs (e.g., Bol, Hacker, O'Shea, & Allen, 2005; Glenberg & Epstein, 1985). More recently, think-aloud protocols have permitted researchers to examine metacognition and calibration through a more qualitative framework (e.g., Gerjets, Kamemerer, & Werner, 2011; Kaakinen & Hyona, 2005). However, these think-alouds are still heavily reliant on quantitative empirical considerations regarding the frequency of keywords or phrases. Hence, our primary purpose was to explore how learners create a *feeling of knowing* (FOK) in their learning. We begin by providing context on research conducted in the area of metacognition and calibration, followed by background information on this project, as well as the theoretical framework and method used in this research.

Review of Selected Literature

We believe it is important to give context to this research and provide our readers with relevant background information related to the research that has been conducted on metacognition and calibration. While there is a breadth of literature available, we have chosen to concentrate on what we consider to be the most significant pieces that led to our desire to conduct the research presented here.

Metacognition is often referred to as the process of thinking about one's thinking. Flavell (1979) described metacognition as the act of taking one's own cognitive processes as the object of one's cognition. In 1984, Palincsar and Brown further refined this definition by stipulating that metacognition refers to one's ability to regulate one's own cognitive behaviors, particularly as they pertain to learning. In an effort to further facilitate the quantitative measurement of metacognition, Schraw and Dennison (1994) created the Metacognitive Awareness Inventory (MAI), a 52-item measure that assesses all eight dimensions of metacognitive awareness, including knowledge and regulation components. The knowledge component includes declarative (the repository of metacognitive strategies available for us), procedural (the steps needed to apply the strategies) and conditional (the where, when, and why to apply strategies given task demands) knowledge. The regulation component includes five dimensions: planning (the process of preparing and anticipating needed resources and roadblocks to learning), information management (strategies needed to control the flow and processing of information), debugging (strategies needed to troubleshoot or problem solve difficulties while learning), comprehension monitoring (one's ability to appropriately monitor comprehension of learning and successfully deflect distractions), and evaluation (a generally holistic reflection of the overall success or failure of the learning episode to improve future learning). Metacognition is a complex, broad concept that encompasses many elements to aid learners control and regulate their learning processes. In this study, we focus on a very specific metacognitive process known as calibration.

Calibration is the process by which learners convey what they know and do not know about a topic. Calibration occurs by asking learners to rate their confidence judgments about their performance on a task—most commonly a performance assessment such as a quiz or exam—and comparing these quantitative judgments to students' actual performance on the assessment (Boekaerts & Rozendaal, 2010; Keren, 1991). Therefore, calibration yields two outcomes, an index of accuracy that provides a metric of the magnitude of the accuracy or inaccuracy of the learner and a direction of the inaccuracy (i.e., error in judging confidence in performance), as learners are very seldom perfectly calibrated in their ratings of performance relative to actual performance (Brannick, Miles, & Kisamore, 2005; Glenberg, Sanocki, Epstein, & Morris, 1987). Error in calibration of learning has been commonly referred to as bias, or the direction of the miscalibration—underconfidence or overconfidence in judging performance (Schraw et al., 2013; Schraw et al., 2014).

The extant literature is replete with studies that have examined calibration in a variety of topics such as the ability of radar technicians to accurately detect a blip on the radar (e.g., Benjamin, Diaz, & Wee, 2009), medicine (e.g., Poses, Cebul, Collins, & Fager, 1985), weather forecasting (e.g., Murphy, 1993), and the social sciences (e.g., Nietfeld & Schraw, 2002; Schraw et al., 2014). However, these studies have focused almost exclusively on quantitative approaches to examining calibration, most commonly by collecting learners' confidence judgments, performance of a referent task, and calibration as dependent variables using self-report methods (e.g., Gutierrez & Schraw, 2015; Hacker, Bol, & Bahbahani, 2008). These studies, while useful to our understanding of calibration, are limited due to their dependence on normative, aggregated statistical data and the many flaws associated with hypothesis testing in quantitative methods. These reductionist approaches do not completely or deeply convey participants' perspectives with respect to the topic. Thus, the purpose of this study was to depart from the majority of the literature on calibration by utilizing a purely qualitative approach to investigating learners' perspectives on the calibration process. We included both proficient and low calibrators as participants to gain a more holistic perspective of the calibration process.

Research on calibration demonstrates that calibration accuracy is related positively to prior knowledge (Tobias, 1995) and achievement (Barnett & Hixon, 1997; Kruger & Dunning, 1999). In addition, accuracy improves when learners have more time to prepare for the task or

the learning episode (Thiede & Leboe, 2009), when metacognitive judgments of performance are delayed (Shiu & Chen, 2013), when learners are provided feedback on their performance (Brannick et al., 2005; Glenberg et al., 1987), when learners are offered an incentive (Hogarth, Gibbs, McKenzie, & Marquis, 1991), and learners are given the opportunity to practice (Hacker et al., 2008). When taken together, these studies support the conclusion that calibration accuracy is a malleable skill that can be enhanced in learners when a variety of scaffolding techniques are used to support learning and self-regulatory activities, particularly for those less proficient calibrators. Nevertheless, these studies do not help us better understand how the calibration process works, especially for proficient versus poor calibrators.

Background to this Project

This study was part of larger mixed-method investigation that formed the pilot study to the dissertation of the primary author. The quantitative component of the article included a demographic questionnaire, the Metacognitive Awareness Inventory, and students' ratings of their performance on a general psychology test that served as the basis to calculate their absolute calibration score. From the results of the calibration accuracy scores, a purposive sample of five proficient calibrators and five low calibrators was selected to participate in the follow up interviews. One of the students who initially agreed to participate in the interviews declined, and hence, there were a total of nine participants. The primary author did not wish to publish these results as a mixed method study, given the low sample size for the quantitative surveys. However, the qualitative interviews were retained for later data analysis, as these data would help researchers better understand metacognition and calibration from a qualitative perspective. These data are presented in this manuscript.

Conceptual and Theoretical Frameworks

In order to move metacognition and calibration from the primarily quantitative world of research into qualitative research, we start by situating this work within Serra and Metcalfe's (2009) discussion regarding the implications of learners' *illusions of knowing* and *not knowing*. In their discussion, they describe these processes as "feelings of knowing" (p. 292) which learners experience as they prepare for a learning episode. For us, re-conceptualizing the conventional linear approach to calibration as a *feeling of knowing* allows us to connect with participants in a meaningful way and tap into their understanding of their own learning process.

In addition to Serra and Metcalfe's (2009) work, we chose to frame this study using self-regulated learning theory (SRL). According to the tenets of SRL, to more completely capture learners' processing we need to consider cognitive, metacognitive, and affective/dispositional characteristics of the learner. Though there are several ways to approach SRL theory (e.g., see Bandura, 2006; Zimmerman, 2000), for this study we opted to use Boekaerts' (1999) model because for us, it emphasizes the role of metacognitive processes of learners in a three-layer model of SRL. The layers of Boekaerts' model with examples are listed below:

> **Layer 1:** Regulation of self-choice goals and cognitive resources.
> ***Example:*** A learner who has a psychology exam next week chooses to study rather than procrastinate demonstrating effective regulation of self-choice goals.
> **Layer 2:** Monitoring of processing methods (i.e., the use of metacognitive knowledge and skills to direct one's learning)

Example: A learner who effectively monitor processing methods, studies for a psychology exam by reviewing the material in order to comprehend rather than as something that is task oriented.

Layer 3: Regulation of processing modes (i.e., the choice of cognitive strategies)

Example: A learner who prepares for an exam and draws a concept map to master the material demonstrates effective regulation of processing modes.

Self-regulated learning theory provided a framework with which to explore the feeling of knowing within our participants including data collection data analysis and interpretation.

Position of the Researchers

Antonio, the primary author and researcher, has extensive experience conducting research in the area of calibration and metacognition while Pamela and Amelia, the second and third authors, bring qualitative research expertise and an outside perspective on the topic. Jason, the fourth author, offers experience in cognitive psychology and linguistics. This research was born out of our desire to more deeply understand the awareness participants had regarding their own metacognition, more specifically their *feelings of knowing* related to their confidence in their performance. We were also interested in gaining a better understanding of whether learners understood the role of metacognitive conditional knowledge (i.e., the where, when, and why to apply a given strategy) in the calibration process. We approached this research aware that our own understanding of metacognition, comprehension monitoring, and *feeling of knowing* as well as our desire to enhance learners' metacognitive awareness made us partial to certain findings and blind to others. Due to our previous experience with metacognition and calibration we brought the following set of assumptions to the research: (1) low calibrators can be helped to enhance their comprehension monitoring skills; (2) *feelings of knowing* can vary depending on domain, topic, content area, etc.; and (3) calibration, which includes *feeling of knowing* judgments (e.g., I'm 95% sure I passed the test.) may be influenced by sociocultural factors including race, gender, ethnicity, level of education, etc.

Method

This study was part of larger mixed-method investigation that formed the pilot study to the dissertation of the primary author. Once findings from the original quantitative study were published, we teamed up ready to embrace the qualitative portion of the study. We conducted a basic interview study (Merriam, 2009) using structured interviews in order to gain an in-depth understanding of the differences between the perceptions and experiences of proficient and low calibrators with respect to their *feelings of knowing.*

Participants

There were nine participants selected for interviews from the larger participant pool in the original research. They were all undergraduate students enrolled in an elementary education program at a large western university and were selected using criterion sampling, which requires participants to meet certain pre-determined criteria (Patton, 2002). Interview participants were recruited electronically via email based on the results of the quantitative calibration exercises the students completed prior to being contacted. Based on participants' calibration accuracy, participants were either labeled as proficient—calibration accuracy was at or above 80 percent—or low—calibration at or below 50 percent—calibrators. Five

participants from each of these groups were invited to participate in the interview process. One proficient calibrator declined to participate in the interview, and hence, nine participants opted in. All participants were over the age of 18, participation was voluntary, but those who participated were given one credit in fulfillment of their research participation requirement. In addition to interview data, demographic information was collected and participants were asked to self-identify in terms of gender and race. The nine interview participants ranged in age from 21 to 54 years old and included 5 White females, one Hispanic female, one African American female, one Asian/Pacific Islander female, and one White male. Institutional Review Board (IRB) approval and participant consent were obtained before the data collection began.

Data Collection

Nine structured interviews averaging 75 minutes each were conducted. Interviews were conducted in a private location on campus at a time mutually convenient for the participant and the primary author. Participants were given an opportunity to review the informed consent form and ask questions prior to the interview. They were fully aware that the interview would be digitally recorded for data analysis purposes. A structured interview protocol was selected because the literature on calibration suggests that students generally know little of the calibration process unless given specific prompts (Azevedo, 2005). Hence, questions were developed based on key concepts derived from review of the literature, the primary author's understanding of SRL theory and knowledge about this particular group of learners (i.e., undergraduates). The list of questions we used in this study can be found in the Appendix.

Data Analysis

The interviews were transcribed and sanitized to remove any identifying participant information. We used NVivo™, a computer-assisted data analysis software package, to organize and systematically analyze the data. Our analysis began with an initial read of the transcripts to familiarize ourselves with the data set and to note those sections of the data that we found most interesting. As we engaged in open reading, we used NVivo™ to individually code the data descriptively (Saldaña, 2013) and make both analytical and theoretical memos. Our individual codes were then merged so we could review one another's codes and memos next to the data set.

Though we set out to analyze the data thematically, along the way we found ourselves narrowing our analysis with a more holistic approach in order to focus more specifically on participants' responses to our initial prompt, "*Please describe the process you underwent in your efforts to calibrate the accuracy of your performance on the test."* We made the decision to first focus on responses to the initial prompt due to the stark differences in responses between low and proficient calibrators. Once we had interpreted these differences, we revisited our merged codes in NVivo™ and moved deeper into the data set proceeding with thematic analysis of data. Specifically, our analytical process included (a) repeated readings of the data, (b) the combining of similar codes into categories, (c) identifying broad patterns across the data, resulting in themes, and (d) selection of representative extracts to document our findings. Throughout this process we remained transparent and reflexive and continually returned to our primary purpose, "to more deeply understand the awareness participants had regarding their own metacognition, more specifically their *feelings of knowing* related to their confidence in their performance." We reflected together on how our assumptions shaped our interpretive process. We reached an acceptable level of data saturation within the two groups of participants. Even though they expressed it in slightly different wording, there was an overlap in the fundamental meaning of participants' experiences regarding their *feeling of knowing*.

The differences in how proficient and low calibrators experienced calibration was also evident in the data, as outlined below.

Results

Through our analysis, we identified two distinct findings. First, low and proficient calibrators understand and articulate their *feelings of knowing* differently. Second, the following four themes permeate *feelings of knowing* for low and proficient calibrators: (1) effort/preparation, (2) strategies, (3) planning, and (4) evaluation. We present each of these findings in detail and provided representative extracts from the data set. Aligning with a Self-Regulated Learning theory framework (Boekaerts, 1999) we discuss each theme and provide supporting literature.

Articulating Feelings of Knowing

Previous research on *feeling of knowing* judgments has highlighted that learners tend to be generally susceptible to the illusion of knowing and not knowing (Serra & Metcalfe, 2009) and that learners who are proficient in monitoring their comprehension are better able to understand what they know and do not know about a topic compared to learner who exhibit low comprehension monitoring. While we did find this to be true in our study and will discuss it later in greater detail, what we found even more surprising was the difference between proficient and low calibrators specifically in regard to the answer connected to the initial interview prompt: "*Please describe the process you underwent in your efforts to calibrate the accuracy of your performance on the test."* Proficient calibrators appeared to understand the initial interview question and were able to quickly identify the process they went through to determine how well they thought they had performed on the test.

An example of how proficient calibrators answered this prompt is:

> I thought back to how well I studied and knew the material and applied it to myself so basically it was just the thought process of how well I, I thought I knew the material. (Participant 55, L 17-18)

Low calibration learners on the other hand had demonstrated difficulty understanding the question. Because these learners were not able to easily identify with the question and needed the prompt explained or refined, we were led to believe that the learners who exhibited low comprehension monitoring may not have adequately understood their cognition, and thus, could not effectively express their *feelings of knowing*.

> Okay, so are you saying like how did I study for it? (Participant 35, L16)

The interviewer had to go through additional steps in the interview process to break down the prompt to the low calibrators before they were able to articulate their *feelings of knowing*.

Creating a Feeling of Knowing

We identified four themes that permeated the *feelings of knowing* for low and proficient calibrators: (1) effort/preparation, (2) strategies, (3) planning, and (4) evaluation. These themes align with Self-Regulated Learning theory (Boekaerts, 1999) and what we found interesting was the extent to which each of these four areas existed and manifested in low and proficient

calibrators when it came to creating a *feeling of knowing.* We discuss each theme here and provide supporting literature.

Effort and Preparation. Learners use cognitive skills and strategies as well as metacognitive knowledge and regulation to successfully prepare for assessments of their learning. Typically, learners are viewed as effective self-regulators of their learning when they can accurately determine what they know and do not know about a given topic or content area. Being able to determine what they know and do not know about a given topic allows learners to focus attention and other cognitive resources on material they have not yet mastered and spend less time reviewing material they already know, thereby effectively demonstrating self-regulated learning behavior.

Proficient calibrators, when examining their effort and preparation for the examination, described their process this way:

> ...how confident I feel about the studying I have done… (Participant 9, L16-17)

When asked how well they will perform on some future assessment of their knowledge, more metacognitive learners come close to accurately predicting their actual performance because they have an increased *feeling of knowing* regarding the knowledge of their performance.

Low calibrators, on the other hand, struggled to share their level of effort and preparation:

> So you're asking me what I did to prepare studywise? (Participant 71, L16)

> Just … you can sort of feel it. (Participant, 71, L113)

Learners who are less metacognitive do not always accurately pinpoint what they know or do not know, and thus, often demonstrating they are less capable of regulating their learning (i.e., they may be lacking in planning, evaluation, information management, or comprehension monitoring skills) and are prone to too much confidence or insufficient confidence when it comes to a *feeling of knowing* about their knowledge and performance.

Strategies. Cognitive strategy use refers to learners' ability to invoke and apply strategies that are conducive to enhanced learning outcomes. The literature on this topic has distinguished between shallow strategies (e.g., surface-level strategies such as rote learning and rehearsal) and deep or meaningful strategies that are more closely aligned to metacognitive monitoring (Greene, Miller, Crowson, Duke, & Akey, 2004) such as reflecting, planning, and evaluation.

Proficient calibrators shared their experience in this way:

> I'll read over all my notes and there will be a study guide and I go through the study guide and every part of the study guide… I'll review and just keep reading the questions and going over the answers… (Participant 55, L34-35; 39)

As noted in Greene et al., deep cognitive strategies such as reflecting, planning, and evaluating, are connected to metacognitive monitoring. Participants shared their intentionality in these strategies: reflecting ("I'll review…"), planning ("I'll read over all my notes and there will be a study guide…"), and evaluating ("…keep reading the questions and going over the answers").

Proficient calibrators also demonstrated reflection, a deep cognitive strategy, by stating:

> ...I generally like to go back and reflect on my notes… (Participant 9, L45-46).

In addition, proficient calibrators continued to demonstrate the strategy of evaluation:

> ...have I retained this information?" (Participant 69, L127)

Proficient calibrators seemed to place a high priority on incorporating reflective practices into their learning process, as well as the importance of self-awareness. Low calibrators did not demonstrate any significant strategies when sharing about their ability to plan for studying or evaluating information. Instead, low calibrators blamed external forces for their lack of understanding or lack of preparation:

> This one (item on exam) I got wrong because it was poorly worded. (Participant 71, L119-120)

In addition, low calibrators struggled with identifying strategies that were not helpful, even after receiving feedback about the ineffective method/strategies:

> ...I was in class underlining too much material (...) she's trying to teach why it is a problem to underline too much because even though she never talked about it in class why it's a problem to underline too much, it's a problem. (Participant 71, L306; 331-334)

Low calibrators consistently struggled with personal responsibility and their learning process:

> I didn't go to class so I didn't recall the information… (Participant 80, L128-129)

Proficient and low calibrators had very different strategies regarding their learning process. Proficient calibrators recognized the importance of incorporating different educational strategies, while low calibrators struggled with using ineffective learning strategies.

Planning. Proficient calibrators plan on many different levels, including attending class regularly, knowing personal strengths and weaknesses, as well as creating ownership in the learning process rather than "cramming":

> I'm all about going to class… (Participant 75, L102)

Proficient calibrators consistently shared information about their planning process:

> ...I attempted to retain as much as possible and then I would take breaks… (Participant 69, L100-101)

This participant recognized taking breaks was an important part of the planning process. Proficient calibrators also planned to incorporate their own learning style into their study process:

> I make my own study guide… (...) I like write down what it's asking for and then put it all in my own words and I use a lot of colors… for some reason I like colors… (Participant 75, L66-68)

Low calibrators again seem to focus on external forces and external locus of control when considering how to plan for an examination:

> When teachers put stuff up on the board it's supposed to be correct, when it's in the book it's supposed to be correct so I just learn it how it is but it's not like I'm paying attention to like does the i come before the z come before the a…(...) So those are kind of stupid unless you are in an English class. (Participant 71, L255-260)

Low calibrators did not seem to understand the importance of planning in understanding the complexities and nuances of what they were learning. Low calibrators also did not create different study strategies for different types of examinations:

> I have the same strategies for all of them. (all examinations) (Participant 80, L75)

Planning differently for different types of exams allows learners to adapt strategies for success. When low calibrators are unable to adapt, they are unable to be as successful as their counterparts.

Evaluation. Evaluation is a metacognitive process and is described as the act of reflecting after a learning episode and making appropriate adjustments for more effective future learning (Schraw & Dennison, 1994; Sperling et al., 2004). For example, low calibrators, even with receiving negative feedback, tended to have an overabundance in confidence of their performance:

> I would say that I do that 80%-90% of the time (have confidence in providing the correct answer on an examination). (Participant 4, L210)

Low calibrators continued to extol their confidence by stating:

> ...on a scale from 1-10 I would say, probably an eight… being like easy, 10 being the easiest (have confidence in performance). (Participant 34, L23-24)

Proficient calibrators, on the other hand, evaluate their understanding through reflection and make changes when necessary:

> I usually like to read through all the answers and then try to reflect back on what the question is asking me again… (Participant 9, L65-66)

Discussion

Kruger and Dunning (1999) argued that the most underachieving tended to be the most *miscalibrated,* overestimating their performance even when faced with negative feedback, thus demonstrating poor comprehension monitoring and evaluation skills. Research suggests that monitoring accuracy is poor and that monitoring judgments affect strategy use. Many studies reveal poor calibration accuracy among adult learners (e.g., see Brannick et al., 2005 and Glenberg et al., 1987 for a review). Nevertheless, research suggests that proficient and low calibrators differ not only in the strategies they use but in their metacognitive processing (Bol & Hacker, 2001; Bol et al., 2005; Gutierrez & Schraw, 2015; Gutierrez et al., 2016; Serra & Metcalfe, 2009). For instance, proficient calibrators are able to plan more effectively for their

learning, and thus, more efficiently allocate cognitive resources and time. Hence, these proficient calibrators are able to execute successful strategies given the demands of the task and are also better equipped to monitor their comprehension and evaluate their learning. On the other hand, low calibrators expend effort and energy on ineffective strategies and rely on a trial and error approach, which hinders their ability to adequately monitor their comprehension of learning and leads to errors in their feeling of knowing (i.e., accurately conveying what they know and do not know about a topic; Gutierrez & Schraw, 2015; Hacker et al., 2008; Serra & Metcalfe, 2009). More concretely, low calibrators may read an expository text including complex information such as texts regarding evolution and believe they have mastered the concepts in one pass when in fact they have knowledge gaps that require re-reading to fill. In sum, proficient calibrators are better able to understand what they know and what they do not know about a given topic or domain. These differences between proficient and low calibrators were consistent with the themes we found in our data. Proficient calibrators were more aware of their cognitive strengths and weaknesses, and hence, better able to employ successful learning strategies whereas the shallow awareness of low calibrators led to poor evaluation of learning, and thus, poor strategy selection and use.

Research conducted in support of SRL theory indicates that effort plays a key role in learners successfully meeting their self-choice goals. For example, learners who are more capable of managing and controlling their effort on learning tasks are apt to show improved performance, confidence in their performance, and a heightened *feeling of knowing* (Corno, 1986; Corno & Rohrkemper, 1985). More specifically, these learners exert additional effort on learning more complex information and less effort on simpler information, and they know when information has been learned so as not to expend unnecessary effort on already-learned information. Hence, effort likely plays a pivotal role in discriminating feeling of knowing skills between these two groups.

Optimal *feeling of knowing* accuracy is arguably necessary for sustained effort while learning. Learners are likely to persevere while tackling a difficult problem if previous experience has demonstrated that they will ultimately succeed in solving it. Nevertheless, if students believe that efforts to master a subject or solve a problem are fruitless, the likelihood that they will persist in such efforts decreases. However, if students feel that they have mastered a topic, they are less likely to expend additional time studying it. Therefore, a low *feeling of knowing* can be expected to result in students misallocating effort in wasteful endeavors. Conversely, an enhanced *feeling of knowing* should permit learners to become more aware of their own cognitive strengths and weaknesses, thereby improving the ability to determine where to best expend effort (Brannick et al., 2005; Glenberg et al., 1987; Schraw, Potenza, & Nebelsick-Gullet, 1993). Effective learning involves a high degree of planning for appropriate allocation, investment, and expenditure of resources and effort. Planning as a metacognitive activity is described as learners' capacity to anticipate cognitive resources necessary to effectively learn and how to effectively allocate those resources to accomplish learning goals (Schraw & Dennison, 1994; Sperling, Howard, Staley, & DuBois, 2004). The use of sophisticated problem-solving strategies, the planning and allocation of resources, as well as monitoring learning and performance are all examples of proficient metacognition. As learners engage in learning activities like preparation for an upcoming exam, they invoke cognitive learning strategies that may include rehearsing, summarizing or transforming learned information into meaningful individual knowledge. They also invoke metacognitive learning strategies such as comprehension monitoring, planning and allocating resources for studying, and understanding when information has been sufficiently learned. In order to successfully navigate and perform the task (e.g., acing the exam itself), learners must be able to appropriately plan so they can get an accurate feeling of what they do and do not know about the topic(s). Proficient metacognitive learners are better able to allocate cognitive resources

and monitor their learning to achieve an increased *feeling of knowing* because they use regulatory skills such as planning, monitoring, and evaluation often and effectively. Less metacognitive learners, conversely, are often less-equipped to perform these functions effectively because they lack the skills to effectively plan for their learning activities (Artzt & Armour-Thomas, 1992; Schraw & Dennison, 1994; Schraw & Graham, 1997), and instead either poorly plan for the demands of the task or employ behaviors such as procrastination. Therefore, these learners tend to exhibit a decreased *feeling of knowing* simply because they are less confident about what they do and do not know.

Research on metacognitive evaluation of learning has found that learners who are more proficient and self-regulated in their learning tend to reflect on previous and current learning activities and make critical changes to their learning process to produce improved learning outcomes in the future (e.g., Garrett, Mazzocco, & Baker, 2006; Ke, 2008; Maniscalco & Lau, 2012). On the other hand, learners who are less metacognitive tend to be less effective at evaluating their learning holistically because they are less likely to spend time reflecting on past and current learning to make appropriate adjustments to future learning activities (e.g., Garrett et al., 2006; Negretti, 2012; Nietfeld, Cao, & Osborne, 2006). As a result, learning outcomes, such as content mastery, academic achievement, and performance within school and professional settings can be undermined because less metacognitive learners may not reflect upon feedback, especially negative feedback, and incorporate it in their learning process for more effective future learning.

In a series of studies, Gutierrez and colleagues (Gutierrez, Schraw, Kuch, & Richmond, 2016; Schraw et al., 2013; Schraw et al., 2014) called attention to the need to better understand the processes underlying metacognitive monitoring, which forms the basis for learners' ability to develop accurate feelings of knowing. In their work, these researchers demonstrated that learners experience and engage in related yet distinct metacognitive processes when making accurate and erroneous judgments. They argued that by more deeply understanding the latent dimensions of metacognitive monitoring, researchers and practitioners could develop more specific, effective, and targeted educational interventions tailored to the low calibrators in particular, who are ripe for improvement in their metacognitive monitoring ability. As this study has demonstrated, proficient and low calibrators experience *feeling of knowing* in fundamentally different ways, and thus, finding ways to better support, model, and scaffold more effective metacognitive monitoring for low calibrators is critical. For classroom teachers, this translates to providing better, more individualized educational interventions to either specifically target the reduction of erroneous feelings of knowing, increase accuracy of feelings of knowing, or both, depending on the deficit of the individual learner. These strategies could then assist learners in appropriately adjusting confidence in what they believe they know and do not know to match what they actually know and do not know. These educational interventions can be compact yet comprehensive and effective at improving the *feeling of knowing* of low calibrators, as research has shown that such interventions, generally incorporating strategy use instruction, are effective at improving metacognitive monitoring judgments (i.e., *feeling of knowing judgments*) among adult learners (Gutierrez & Schraw, 2015) and children in ecologically valid school settings (Gutierrez de Blume, 2017). Thus, the findings of the present investigation have bearing on both PK-12 educators and higher education faculty.

For PK-12 and higher education administration this study's findings suggest the need to provide additional support and resources to educators and faculty to enhance curriculum and pedagogy that fosters the development of proficient metacognitive monitoring skills, thereby improving feeling of knowing accuracy, among children and adult learners. This could take the form of providing space and time for professional development opportunities to educators and faculty to learn how to better model and scaffold feeling of knowing accuracy in their

classrooms and how to better incorporate metacognitive monitoring skills in their curricula, which would be especially beneficial for low calibrators. In addition, administrators at both levels of education can consider offering incentives for lessons that demonstrate some level of incorporation of metacognitive monitoring skills training as an active part of the lesson to encourage transitioning to this frame of teaching. Moving away from extrinsic incentives, administrators could highlight the benefits to active, consistent lessons, activities, and assignments that instill metacognitive monitoring skills in learners such as improvements in retention of information, metamemory skills, and achievement.

A large majority of research on metacognitive monitoring is focused exclusively on adult learners, namely college undergraduates, as was the case in this study. While understanding young adult learners is important and necessary, additional research is warranted on samples along the developmental trajectory of metacognition. For instance, research has yet to explore how metacognitive awareness develops in children. In addition, a dearth of research exists on how this phenomenon operates in adults of middle age or within geriatric populations. Using qualitative approaches would be most informative in helping scholars to develop, for example, a grounded theory that is able to capture the shifts in metacognitive development across the lifespan. Additional research is also needed from perspectives other than those of the individual. To this end, interviews could be employed to solicit feedback from teachers and parents regarding the metacognitive skills of children. Quite possibly, this information could provide triangulation when coupled with interviews of individual learners. If data among these three sources (i.e., individual, parent, teacher) diverges, this could provide additional fodder for scholars to explore metacognitive skill application using observations.

Methodological Reflection and Limitations

Qualitative research is not appropriate for every research question. Every study has limitations, and this study is no different. One significant limitation is the lack of observational data. Communication is more than verbal interaction; the interviews were not video recorded, and therefore, some significant data was not able to be analyzed. There is much to be gained by examining a participant's way of being in the interview.

Another limitation of this study is the uneven amount of participants in this study. There were 4 proficient calibrators and 5 low calibrators. The data may have been richer with an equal number of participants from each category of learner.

Conclusion

It is our hope that meaningful change occurs for all learners, especially those who exhibit lower levels of metacognitive awareness. However, a necessary first step to achieve this goal is to gain a more in-depth understanding and awareness of the metacognitive process for both proficient and low calibrators. This change could significantly impact learners, our educational delivery system, and educational policy. By allowing for, and adjusting our current philosophical stance on metacognition and calibration, we believe the next generation of learners could be significantly impacted.

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Appendix

Interview Questions

Calibration refers to the extent to which individuals can judge the accuracy of their performance. I am going to ask you several general questions regarding how you calibrate the accuracy of your performance on tests/exams.

1. The calibration process involves an individual monitoring his or her knowledge regarding a specific topic, skill, or task and then reflecting on the extent of that knowledge in comparison to his or her performance on a criterion task, such as a test/exam. Therefore, calibration is a metacognitive process that individuals invoke to regulate their behavior. Could you please describe the process you underwent in your efforts to calibrate the accuracy of your performance on tests/exams?

2. How difficult do you find it to calibrate the accuracy of your performance?

3. What are some of the specific strategies you used while calibrating in preparation for tests/exams?

4. Could you please describe how you use these strategies as you calibrate?

5. How do you know when your calibrations are accurate? In other words, what internal criterion (or criteria) do you use to evaluate your judgments?

Real-Time Introspective Questions

I have here a copy of the exam you took in class. I would like you to imagine that that you are sitting in class taking the exam as if for the first time. As you respond to each item I would like you to tell me what you are thinking. Say anything that comes to mind.

1. How prepared would you say you were for the exam? How do you know?

2. What specific strategies did you use to prepare for the exam, if any?

3. How confident were you in your knowledge about the exam? Did your confidence change after the exam? If so, in what specific ways?

4. Is there anything you would have done differently in terms of preparation for the exam? If so, what specifically would you have done differently?

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Article Citation

Gutierrez de Blume, A. P., Wells, P., Davis, C. A., & Parker, J. (2017). "You can sort of feel it": Exploring metacognition and the feeling of knowing among undergraduate students. *The Qualitative Report, 22*(7), 2017-2032. Retrieved from http://nsuworks.nova.edu/tqr/vol22/iss7/18