A CORRELATIONAL STUDY OF NONCOGNITIVE VARIABLES AND STUDENT SUCCESS IN DENTAL EDUCATION

by

Jennifer Lynn Keim Wibbeler

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

In 1995, the Institute of Medicine (IOM) published *Dental Education at the Crossroads: Challenges and Change*, advocating for a revolution in dental education. Notably, it recommended that course content, structure, and delivery be modernized in response to graduating clinicians lacking the critical thinking and problem-solving skills required in a patient care setting. To help determine if current dental education trends are promoting these skills, the purpose of this cross-sectional, correlational study is to investigate the relationship between students' noncognitive variables (self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit), as predictor variables, and self-directed academic performance (as measured by end-of-term Yammer scores), the criterion variable. Eighty-eight participants were recruited, via convenience sampling, to participate in this study. The Learning Self-Regulation Questionnaire, Index of Autonomous Functioning, Motivated Strategies for Learning Questionnaire, and Grit Questionnaire were distributed in a single software package facilitated by Qualtrics. The results of the multiple regression analysis demonstrated no predictive relationship between this model of noncognitive variables and self-directed learning, explaining only 0.3% of the variance. The study conclusions, implications, and recommendations for future research are discussed.

Keywords: noncognitive variables, self-directed learning, self-regulation, motivation, autonomous functioning, learning strategies, grit

Acknowledgments (Optional)

The acknowledgments page provides the opportunity for the candidate to acknowledge individuals who influenced the writing and completion of the dissertation. This page is optional.

My doctoral path has not been an easy one. I consistently stayed a full-time student all the way up to the dissertation phase while working full-time and handling my growing family. I wore many hats and kept many plates spinning. There were times of early mornings, late nights, tears, and burnout, but several people helped me keep my faith in this endeavor. It is to these people I owe my thanks and love.

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List of Abbreviations

Institute of Medicine (IOM)

American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI)

Grade Point Average (GPA)

Dental Aptitude Test (DAT)

Self-Directed Learning (SDL)

Case-Based Learning (CBL)

Problem-Based Learning (PBL)

Social Cognitive Learning Theory (SCLT)

Self-Regulated Learning (SRL)

Self-Determination Theory (SDT)

Commission on Dental Accreditation (CODA)

Learning Self-Regulation Questionnaire (SRQ-L)

Academic Self-Regulation Questionnaire (SRQ-A)

Index of Autonomous Functions (IAF)

Motivated Strategies for Learning Questionnaire (MSLQ)

End-of-Term (EOT)

Relative Value Point (RVU)

Cumulative Point Average (CPA)

eXtensible Competencies Platform (XComP)

Institutional Review Board (IRB)

Variance inflation factor (VIF)

CHAPTER ONE: INTRODUCTION

Overview

This quantitative, cross-sectional, correlational survey study explores the potential relationship between students' noncognitive variables and self-directed learning academic performance. Chapter One provides the background for contemporary dental school education topics, recent calls to action, and noncognitive variables. The background section includes an overview of the theoretical frameworks applied in this study. The problem statement explores the scope of recent literature on this topic. The purpose and significance of this study are discussed. One research question was identified, and the predictor and criterion variables are described. Finally, definitions that are pertinent to the study are provided.

Background

Studies suggest that current methods of instruction are not adequately preparing dental school graduates for the practice of dentistry (Formicola, 2017; Licari & Evans, 2017; Rutkauskas et al., 2015). One such study demonstrated that dental school clinics operating as teaching laboratories are not providing sufficient practice in the diverse skills necessary for a dental practice, such as fine motor skills, diagnostic skills, administering pain remedies, and performing restorations (Licari & Evans, 2017). Furthermore, these clinics do not provide the authentic educational experiences needed to practice general dentistry, which is the ability to diagnose, manage, and treat diseases of the dental tissues (Fontana et al., 2017; Kassebaum & Tedesco, 2017). Another study suggested that graduates are woefully unprepared to address patients with special needs or special populations such as pediatric patients. (Rutkauskas et al., 2015). There is a need to address the shortcomings of dental education. While some suggest that there needs to be an overhaul of the curriculum, this task is not as simple as it seems (Licari &

Evans, 2017). Instead, research should examine student abilities and how institutions can best meet their needs.

Historical Overview

In 1995, the Institute of Medicine (IOM) published *Dental Education at the Crossroads: Challenges and Change*, which advocated for a revolution in dental education. Notably, the authors recommended that course content, structure, and delivery be modernized in response to graduating clinicians lacking the critical thinking and problem-solving skills required in a patient care setting. This notion was advanced when the American Dental Education Association Commission on Change and Innovation in Dental Education (ADEA CCI) compiled *Beyond the Crossroads: Change and Innovation in Dental Education* (2009). This compilation recommended methods for developing curricula that could change to promote content mastery and application. Additionally, changes to accreditation standards and competency statements have required students to be more active learners and practice synthesizing and applying their knowledge to various situations (Commission on Dental Accreditation, 2019). Since then, dental schools have sought to implement an integrated curriculum that promotes more self-directed learning and improves students' critical thinking skills. However, students are more acclimated to passive learning. Because of this, dental students are often underprepared and exhibit difficulty adjusting to this style of curriculum (Watkins, n.d.).

Literature suggests that noncognitive variables can assist faculty in assessing student abilities even before they begin dental school (Farrugia et al., 2018; Sedlacek, 2004). Traditionally, cognitive measures such as undergraduate grade point averages (GPA) and standardized test scores have been applied as measures for determining the admissions filtering process. Studies have shown that these methods are reliable and valid predictive measures of

student ability and skills (Bridgeman et al., 2000; Kuncel et al., 2004; Kuncel et al., 2005; Noble, 1991; Roberts et al., 2007). To most educators, however, this is an incomplete perspective pertaining to students' academic performance. To resist this, some school sites introduce noncognitive variables to predict student performance, retention, and academic achievement (Oswald et al., 2004). Noncognitive variables can be defined as "variables relating to adjustment, motivation, and student perceptions, rather than the traditional verbal and quantitative (often called cognitive) areas typically measured by standardized tests" (Sedlacek, 2004). While some studies have shown that examining noncognitive variables are more effective at predicting student success and persistence in college and professional schools (Farrugia et al., 2018; Sedlacek, 2004), others have shown mixed results (Thomas et al., 2007). In their study, Farrugia et al. (2018) found that academic mindsets, academic perseverance, learning strategies, social skills, and academic behaviors positively affect academic success (χ^2=2411.58; CFI = .91). However, Thomas et al. (2007) found that noncognitive variables as measured by the Non-Cognitive Questionnaire were largely unrelated to college performance as measured by GPA, college persistence, and credits earned (GPA range is r_{obs} = –.05 - r_{obs} = .07; persistence r_{obs} = –.08 - r_{obs} = .14; credits earned r_{obs} = .04 - r_{obs} = .15).

Society-at-Large

To date, United States dental admissions committees have examined academic and cognitive data such as Dental Aptitude Test (DAT) scores and grade point averages to select ideal candidates. However, studies have shown that these factors are insufficient for accurately predicting academic performance once students have matriculated into dental school (Curtis et al., 2007). In response to this, higher education institutions, foundations, and even scholarship programs have employed noncognitive variables in conjunction with academic and cognitive

data as an all-inclusive predictor for student success (Thomas et al., 2007). The relationship between noncognitive variables and other measures such as biographical information, personal interviews, and letters of recommendation regarding college student performance has been extensively studied (McCarthy & Goffin, 2001; Scott et al., 1995). These variables influence student success and can add validity to the traditional predictors. However, implementing these in dental school admissions processes is still relatively new. Newer still is applying them after students have enrolled to predict and monitor student academic performance regarding self-directed learning. The goal of employing noncognitive variables is to aid decision-makers in obtaining information about students to improve their ability to predict success. This information can then be implemented to develop appropriate interventions that are aimed at improving academic performance.

Theoretical Background

Dental students are a unique population. They are experienced students and are motivated by their desire to achieve self-directed goals (Fang, 2002). The social cognitive learning theory and adult learning theory could be applied as frameworks to help understand how noncognitive variables can aid educators in predicting student academic performance. The social cognitive learning theory suggests that learning depends on an individual's personal factors (cognition, affect, and biological events), behavior, and environmental influences (Bandura, 1977). The adult learning theory posits that adults naturally learn differently due to the prior knowledge and experiences that their adolescent counterparts do not possess (Knowles, 1984). Literature suggests a need for more valid and unbiased predictors of student success in higher education programs (Sackett et al., 2001, Thomas et al., 2007; Wilson et al., 2014). Combining elements from social cognitive learning theory and the adult learning theory results in a better

understanding of students' motivations, learning styles, and ultimately academic success. Furthermore, institutions are better equipped to predict the ability of the student to academically achieve within their programs and serve those who experience challenges (Bean, 1980; MacKinnon-Slaney, 1994; Tinto, 1993).

Psychologists have suggested that noncognitive variables such as self-regulation, autonomous functioning, implementation of learning strategies, grit, and motivation can be equally valuable predictors of academic success (Rosenberg, 2019; Sadlecek, 2017; Schneider & Preckel, 2017; Virtue et al., 2017). As such, this study will focus on *self-regulation, intrinsic motivation, autonomous functioning, learning strategies,* and *grit* as predictor variables. Literature has discussed that a student's ability to self-regulate elicits positive benefits for behavior and the acquisition of skills (Reid, 1993; Zimmerman, 2001), "Self-regulation refers to the self-directive process through which learners transform their mental abilities into task-related skills" (Zimmerman, 2001). Learners apply self-regulation to monitor attention, thoughts, and emotions and transfer them into skills implemented for learning. It is the process of continuously monitoring progress towards goals, checking outcomes, and redirecting unsuccessful efforts (Berk, 2003). Students who can regulate their emotions and behavior are able to better engage with other students and respond to the varying activities.

According to Yeagear et al. (2017), autonomy is a basic component of motivation as it provides learners with a sense of freedom, self-reliance, and self-regulation. This has been shown to increase a student's interest, choice, or perceived value of the task, which, in turn, increases a student's intrinsic motivation (Heindle, 2018; Jaegle et al., 2019). As such, autonomy has been considered as one of the principal goals of education (Dole et al., 2017). Studies have shown that faculty who provide a significant degree of autonomy in curriculum delivery teach students that

are more engaged, exert more effort, and display interest in the content (Dole et al., 2017; Yeager et al., 2017).

Learning strategies are techniques students implement to organize and apply skills to learn content or accomplish goals more effectively and efficiently (Schumaker & Deshler, 1992). They can further employ these skills to improve learning and academic success. According to Schumaker and Deshler (1992), these are conscious, intentional techniques that can be adapted based on the learning situation or task. These strategies can include rehearsal, elaboration, organization, monitoring, and affective strategies (Schunk, 2020).

Grit is a non-cognitive variable defined as an individual's perseverance of effort and passion for reaching long-term goals (Duckworth et al., 2007). Studied extensively by Angela Duckworth and her colleagues, they concluded that students who were considered "gritty" (Arya & Lal, 2018) were more likely to maintain their resolve and motivation despite challenges. Furthermore, they concluded that grit is a viable predictor of student success based on their studies of Ivy League graduates, cadets of the West Point United States Military Academy, and student ranking on the National Spelling Bee.

Central to all noncognitive variables included in the present study is motivation. "Motivation provides a source of energy that is responsible for why learners decide to make an effort, how long they are willing to sustain an activity, how hard they are going to pursue it, and how connected they feel to the activity" (Di Serio et al., 2013, p. 586). Literature suggests that motivation is necessary in the learning process as it encourages students to exert the effort to learn (Budiman, 2016; Gopalan et al., 2016). As such, it is a central concept in noncognitive variable research. It has been shown to increase the effective implementation of learning strategies (Kahn et al., 2019) and promote self-regulated learning (Di Serio et al., 2013). Di

Serio et al. (2013) also suggested that academically motivated students tend to engage, persist, and expend effort to complete tasks compared to unmotivated students, which promotes student grit. On the other hand, a lack of motivation has been shown to be a significant obstacle to learner success (Wei et al., 2015).

In its broadest sense, self-directed learning (SDL) refers to the ability to identify an individual's own learning needs, determine learning goals, choose sources and materials needed to learn, apply appropriate learning strategies and assess learning outcomes with or without help from another individual (Knowles, 1975). As such, it is a process whereby individuals assume primary responsibility for planning, continuing, and evaluating their learning experiences (Merriam et al., 2007). In dental education, two models based on SDL are case-based learning (CBL) and problem-based learning (PBL).

At the present study's research site self-directed learning is conducted via CBL and PBL discussions conducted on Yammer, an online microblog and collaboration tool powered by Microsoft (T. Watkins, personal communication, July 15, 2021). In CBL, a pre-determined case is created and presented by a faculty member for small groups to solve (Watkins, n.d.). This occurs in a classroom where the student groups are seated together, collaborate to solve the case, and document their discussions on Yammer (T. Watkins, personal communication, July 15, 2021). The faculty member leads the activity by releasing one component of the case at a time, ensuring that the focus of the exercise is the understanding and application of knowledge in clinical practice (T. Watkins, personal communication, July 15, 2021). For PBL, students are encouraged to employ Yammer to discuss concepts or problems (Watkins, n.d.). Again, students are disaggregated into predetermined groups and all discussions occur online where faculty members are encouraged to join these discussions in order to direct them without directly

providing the correct answer (T. Watkins, personal communication, July 15, 2021). According to Miller and Morris (2014), students who participate in virtual environments, such as Yammer, are still influenced by social interactions. However, further research is needed to understand these interactions fully.

Problem Statement

There is ample literature pertaining to the current trends of academic achievement predictors in higher education. Currently, traditional cognitive measures, such as standardized test scores and GPA, have been the strongest predictors of higher education academic performance (Cho & Serrano, 2020; Schneider & Preckel, 2017). However, literature has not adequately discussed how these measures predict dental school success. Instead, recent studies have examined elements of undergraduate study, such as choice of major, undergraduate coursework grades, and participation in pipeline programs (Chow & Milos, 2019; Rowland & Rieken, 2018; Sabato et al., 2019). Furthermore, one study suggested that traditional cognitive measures are limited in predicting student success in dental schools (Wilson et al., 2014).

Multiple gaps exist within the current literature. First, research examining the relationship between noncognitive variables and academic outcomes in higher education has focused on the effect of single variables at a time. For example, Pate et al. (2017) examined grit, Han et al. (2017) investigated academic mindsets, and Van Rooij et al. (2018) focused on self-efficacy. Due to their singular foci, the results from these studies are difficult to generalize and have resulted in an incomplete perspective of student abilities. Very few studies have combined several noncognitive skills to create a functional prediction model to help institutions identify student strengths and weaknesses (Farrugia et al., 2018; Sadlecek, 2017; Virtue et al., 2017).

Another gap is that most literature regarding noncognitive variables and professional schools encompasses an examination of how to apply them during the admissions process (e.g., De Visser et al., 2018; Hossler et al., 2019; Sadlecek, 2017). Furthermore, very little research demonstrates their implementation in dental school settings (Price & Park, 2018; Wilson et al., 2014). Academic success in dental school is a complex concept based on a combination of variables from cognitive, noncognitive, demographic, and psychological contexts. Studying noncognitive factors can help educators better understand why students persist and succeed in dental school. These variables can then be applied to select candidates who are likely to succeed in dental school and develop interventions to help students who encounter challenges (Rosenberg, 2019).

For this reason, there is a need to investigate more holistic approaches that advance beyond these measures and examine the variables that personally motivate students (Cho & Serrano, 2020; Rosenberg, 2019). Psychologists have suggested that noncognitive variables such as self-regulation, autonomous functioning, implementation of learning strategies, grit, and motivation can be equally valuable predictors of academic success (Rosenberg, 2019; Sadlecek, 2017; Schneider & Preckel, 2017; Virtue et al., 2017). As such, this study will focus on *self-regulation, intrinsic motivation, autonomous functioning*, *learning strategies,* and *grit* as predictor variables. The problem is more research is needed to determine if there exists a relationship between dental students' self-directed learning and a linear combination of noncognitive, potentially confounding variables affecting learning (Farrugia et al., 2018; Price & Park, 2018; Sadlecek, 2017; Virtue et al., 2017; Wilson et al., 2014).

Purpose Statement

The purpose of this quantitative, predictive correlational study is to determine the potential predictive relationship between noncognitive, potentially confounding variables that may affect learning and self-directed learning academic performance. Correlational analysis will indicate if fluctuations in the predictor variable, noncognitive variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies*, and *grit*), and criterion variables (end-of-term Yammer grades) representing student self-directed learning are related. Student self-directed learning will be measured by examining students' end-of-term Yammer grades.

For the present study, the noncognitive variables examined include *self-regulation, intrinsic motivation, autonomous functioning, learning strategies*, and *grit*. According to Valenzuela et al., (2020), self-regulation includes self-motivation (i.e., goal setting, learning from mistakes) and volitional regulation (i.e., strategic decision making). Essentially, it is the degree of a person's motivation to perform a particular behavior as autonomous or relatively controlled (Ryan & Connell, 1989). Intrinsic motivation includes students' curiosity, ability to overcome new tasks, and collaboration skills (Whitehead, 1984). According to Schunk (2020), intrinsic motivation strengthens one's will and determination to satisfy needs while resolving conflicts.

Autonomous functioning can be described as "the need to self-regulate one's experiences and actions, entailing a form of functioning associated with feeling volitional, congruent, and integrated" (Ryan & Deci, 2017). According to Ryan and Deci (2000), the need for autonomy refers to a sense of control or agency in interactions in the environment. The adult learning theory suggests that adults learn more effectively when educators act as guides and allow students to assume more control over learning decisions (Rabourn et al., 2018). Learning

strategies are cognitive plans oriented toward successful task performance (Schunk, 2020). In the process of learning, the student selects necessary learning strategies to facilitate the achievement of learning goals. Their ability to do so determines the level of self-regulated learning, which has been related to increased academic performance (Matcha et al., 2019). Grit can be defined as the "perseverance and passion for long term goals" (Duckworth et al., 2007). It entails persistently working towards a challenging goal while sustaining effort over extended periods despite challenges (Duckworth & Yeager, 2015). Grit is considered a significant predictor of success and excellence in every domain regardless of giftedness or talent (Duckworth et al, 2007; Duckworth & Yeager, 2015).

The participants for this study were recruited via convenience sampling during the spring term of the 2021-2022 school year from a dental school located in a middle-class municipality in North Carolina. As all students have actively participated in CBL and PBL learning encounters at this site, a survey was sent to all 204 currently enrolled students. From this pool, a total of 88 participants completed the survey.

Significance of the Study

This study adds to the existing literature by exploring the relationship between noncognitive variables and students' academic success. Little to no research has been conducted in dental school settings that incorporate multiple, combined, noncognitive variables as predictors of academic performance. Most studies have focused on a singular noncognitive variable and its application in dental school admissions. This suggests that what is known about noncognitive variables only reveals a portion of students' abilities and skills. As such, this study seeks to explore how studying multiple variables, and their interactions may produce a different, perhaps more or less significant result. Furthermore, studying multiple variables concurrently

allows the researcher to assess which noncognitive variables can be combined to form the best prediction of students' academic success.

Few studies have provided a framework inclusive of multiple, combined, noncognitive variables introduced in the same investigation. Of those that exist, a majority are meta-analyses. Tinto (1993) and Bean (1983) provided frameworks that facilitated the examination of how sociocultural factors, such as institutional culture, expectations, and faculty-student interactions, affect student success. Robbins et al. (2004) conducted a meta-analysis examining how educational and motivational theories and students' study skills influenced student academic performance, focusing on time management, communication with teachers and advisors, and note-taking. Whipple and Dimitrova-Grajzl (2021) explored how grit and person-environment influenced the academic performance of students that attended a military college. Yeager and Dweck (2012) demonstrated that social and psychological interventions could affect noncognitive variables and student success. Hattie et al. (1996) also indicated how interventions targeting metacognitive (self-management, self-monitoring) and affective (motivation, self-concept) skills also affected student outcomes. While these studies provide a guide for conducting investigations with multiple variables, they are not without their limitations.

Presently, a significant number of studies examining the relationship between noncognitive skills and academic performance in higher education have focused on single variables. For example, Walsh and Robinson Kurpius (2016) studied educational goals while Kitsantas et al. (2008) investigated time management skills. While these studies have facilitated an understanding of how noncognitive variables relate to academic outcomes, they do not consider how multiple variables, or their interactions, can collectively affect results, thus resulting in an incomplete perspective of how noncognitive variables predict academic

performance. This study explores how the combination of multiple combined variables relates to students' abilities and success in dental school. Understanding these elements and their interactions can provide better understanding of students' anticipated success in professional school settings.

This study explores the effects of self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit on academic outcomes. As many studies on these topics have been meta-analyses, the proposed study will attempt to overcome the limitations of a meta-analysis such as the inclusion of studies that lack internal, external, construct, and statistical conclusion validity, and the diversity of methods applied in studies potentially leading to erroneous inferences (Stone & Rosopa, 2017). Directly examining the relationship between noncognitive variables and students' self-directed learning scores permit the researcher to fully explore noncognitive variables' fluidity. This presents educators with a more holistic understanding of the behaviors of students. This study may also support practical applications in developing custom interventions intended to improve academic performance.

Research Question

The research question for this study is:

RQ1: How accurately can self-directed academic performance as measured by end-of-term Yammer grades be predicted from a linear combination of noncognitive variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit*) for dental students?

Definitions

1. *Autonomous functioning* – Autonomous functioning can be described as a person's desire to self-regulate their experiences and actions (Ryan & Deci, 2017).
2. *Cased-Based Learning (CBL)* - Learning that is faculty-directed, single-disclosed, or progressively-disclosed, clinical case-focused work that will result in a final document for grading relative to a rubric for quality (Watkins, n.d.).
3. *Cognitive variables* – Cognitive variables are measures of prior achievement such as high school grade point average (HSGPA) and standardized test scores (Attewell et al., 2011).
4. *Demographic variables* – Demographic variables are predictors such as gender, race, and socioeconomic status (Reason, 2009).
5. *Grit* – Grit can be defined as the perseverance and passion to achieve long term goals (Duckworth et al., 2007).
6. *Learning strategies* - Cognitive plans oriented toward successful task performance (Schunk, 2020)
7. *Motivation* - Processes that instigate and sustain goal-directed activities (Schunk & DiBenedetto, 2020).
8. *Noncognitive variables* - Variables that relate to a student's adjustment, motivation, and perceptions, rather than the traditional, often referred to as cognitive areas, typically measured by standardized tests and Grade Point Averages (Sedlacek, 2004).
9. *Problem-Based Learning (PBL)* - Learning that uses is open-ended, student-directed, and faculty-augmented discussion of any problems related to a dental educational program (Watkins, n.d.).

10. *Self-regulation* – Self-regulation includes both self-motivation and volitional regulation to set goals and strategically plan how to achieve them (Valenzuela et al., 2020).

CHAPTER TWO: LITERATURE REVIEW

Overview

With a call to action to modernize the dental curriculum, schools have sought ways to incorporate more self-directed learning opportunities that improve students' critical thinking skills. This chapter will begin with reviewing the social cognitive theory and adult learning theory to situate this study within a greater context. Then, research related to noncognitive variables in higher education classes, including professional level schools such as medical and dental schools, will be reviewed. Self-directed learning (SDL) opportunities such as case-based learning (CBL) and problem-based learning (PBL) within these settings will also be explored. This chapter also addresses inconsistencies in the research and results reported in the existing literature and reveals the need for more research on noncognitive variables in dental education.

Theoretical Framework

The theoretical framework includes a review of relevant educational theories believed to affect higher education success and persistence. The social cognitive learning theory explores motivation, learning, and self-regulation in social environments. The adult learning theory includes how adults are a unique learning population worthy of unique considerations in education. Additionally, Farrington et al. (2012) created a theoretical framework for understanding noncognitive attributes and student GPA among college and K-12 students. These theories guided the study design and analysis.

The Social Cognitive Learning Theory

The social cognitive learning theory (SCLT) is a theoretical framework of human behavior that emphasizes the influence of the social environment on motivation, learning, and self-regulation (Schunk & Usher, 2019). Originating from Albert Bandura's foundational theory,

the social learning theory, this posits that learning occurs in social settings whereby participants observe and mimic each other's behaviors (Bandura, 1977). This comprises four main assumptions: attention, retention, reproduction, and motivation (Bandura, 1977). Attention, or the ability to focus on the present matter, is required for learning. Bandura advances this idea by claiming that the more novel or different the current task, the more likely it will maintain a person's attention. This is similar to Jaegle et al.'s (2019) discussion where unique forms of learning excite the learner and maintains attention for longer periods while increasing motivation. These ideas are further reinforced when examined in social settings. The second assumption is that knowledge retention is based on the context in which it was observed (Bandura, 1977). As such, information previously learned is consistently recalled and applied to new, similar settings. This allows knowledge to constantly evolve into more complex thoughts, actions, and learning strategies that can be applied in various settings.

Similarly, the third assumption is that reproduction of previously learned information occurs on demand and is contingent on practice (Bandura, 1977). The more the information is applied, the more likely it is that knowledge and application will improve (Schunk, 2020). The final assumption is motivation. Often, motivation originates from observing others of like abilities being rewarded or punished for their actions (Bandura, 1977). Based on these observations, a person is motivated to reproduce similar behaviors and expect similar results and consequences. This, in turn, creates *outcome expectancies*, which are cognitive beliefs that are developed through social interactions and reinforced by practice (Bandura, 1977).

The social learning theory emphasizes *observational* or *vicarious learning.* This is learning that occurs without direct action by the learner (Bandura & Walters, 1963, Bandura, 1977b). According to Bandura (1977b), this occurs most successfully in face-to-face

environments, however, interactions with peers and teachers can occur in a virtual environment as well (Miller & Morris, 2014).

Bandura eventually shifted his focus from *vicarious learning* to those personal influences that can affect learning. Motivation is defined as the *"*processes that instigate and sustain goal-directed activities" (Schunk & DiBenedetto, 2020). SCLT follows *triadic reciprocality* or *reciprocal interactions* model which suggests that humans operate within a set of behavioral, environmental, and personal influences that are continuously intersecting (Bandura, 1986). Schunk and DiBenedetto (2020) discussed these influences as behavior influencing correlation to a person's ability to apply essential knowledge and skills to perform the desired behavior. Like the reproduction aspect of the original social learning theory, before being able to perform a task on-demand, a person must first know what to do and how to do it (Schunk & DiBenedetto, 2020). Furthermore, people usually learn from their actions via consequences determined by the environment in which the action occurs (Schunk & DiBenedetto, 2020). The environment relates to any external factor, such as social factors, influencing behavior (Schunk & DiBenedetto, 2020). Finally, personal influences relate to a person's cognition, which includes mental processes such as emotions, outcome expectancies, behavioral capability, and self-efficacy (Schunk & DiBenedetto, 2020).

One primary element of the SCLT is the focus on motivation (Bandura, 1986). *Triadic reciprocality* suggests that motivation is connected to one's personal, environmental, and behavioral influences (Bandura, 1986). Personal influences are the most significant as they pertain to motivation and include goals and self-evaluations of progress, self-efficacy, social comparison, attributes, values, and outcome expectancies (Schunk & DiBenedetto, 2020). Central to this model is a student's self-efficacy or belief in overcoming a challenge (Schunk &

DiBenedetto, 2020). This relies on self-regulatory conditions that help a person decide the actions and time necessary to achieve the desired goal (Schunk, 2020). This can be improved by mastery of tasks, vicarious experiences, or watching others succeed (Conner & Norman, 2005). Students who are confident in their learning abilities feel self-worth and display greater interest and motivation, which, in turn, enhances achievement (Schunk, 2020).

The student's ability to establish goals and expectations are substantial motivating factors related to a student's self-efficacy behavior (Schunk, 2020). According to Dunn and Kennedy (2019), goal-orientated motivating factors present external rewards, such as excellent grades obtained from learning. When a student perceives a discrepancy between his or her goal and performance, it creates motivation to change behavior (Schunk, 2020). When students accept ownership of their education, they set behavioral expectations and adopt more profound learning methods to achieve their goals (Lavy, 2020). Whitehead (1984) suggested that students who assumed responsibility for their education practiced self-learning by actively seeking information and increasing their overall academic achievement. For this reason, applying SDL in creative ways that challenge students forces them to become active learners and encourages more profound learning methods that can increase their motivation (Jaegle et al., 2019; Lavy, 2020; Sumuer, 2018).

A student's emotional engagement, or his or her perceived value of the task, helps determine his or her degree of motivation (Özhan & Kocadere, 2020). If the students perceive significant value inherent to the content but do not think the completion of their task is possible, they look to those comprising their environment and compare themselves (Schunk, 2020). Seeing others of similar ability succeed or fail influences how a person can complete a given task directly. This is referred to as *social comparison* (Schunk, 2020). When students base their

actions on models of similar ability, the observer is more likely to mimic the appropriate steps necessary to complete a task and produce similar results (Schunk, 2020). Another way social comparison boosts motivation is by creating competition (Ingrassia et al., 2018). Competition can motivate students to perform at a more significant level than those comprising their immediate environments. One method by which students accomplish this is by reflecting on their past experiences and successes while applying similar strategies to achieve their goals (Araya et al., 2019).

Adult Learning Theory

Dental students should be perceived not as traditional learners but as a unique product of the learning processes experienced by adults. Defining the term "andragogy" to separate adult learners from children, Malcolm Knowles first introduced the idea that adults naturally learn differently due to prior knowledge and experiences that their adolescent counterparts have not experienced (Knowles, 1984). Key components of this theory suggest that adult learners are more independent, self-directing, and have learned from their prior experiences (Knowles, 1984). Additionally, they "are more interested in immediate problem-centered approaches and are motivated more by internal than external drives" (Knowles, 1984, p. 11). According to Kenner and Weinerman (2011), these attributes comprise the four pillars of adult learning and should be embraced to address this student population's needs fully.

Since adult learners are more self-directed, they are more likely to assume greater control and responsibilities over their actions (Gouthro, 2019). As the SCLT suggested, the more ownership students exert over their education, the more they establish their behavioral expectations and adopt deeper learning methods to help them achieve their goals (Lavy, 2020). This can also be explained as a heightened level of self-regulated learning (SRL) (Kenner &

Weinerman, 2011). SRL can be defined as a "form of learning in which the person self-determines one or more self-management measures, depending on the type of learning motivation (intrinsic or extrinsic), cognition, metacognition, volition, and behavior, and supervises the progress of the learning process itself" (Schiefele & Pekrun, 1996). Likewise, Knowles suggested that adult learners sense they benefit more from their education if they control their education as much as possible (Knowles, 1990). This indicates that an individual's learning is unique, and students should be more active participants in their education. This is accomplished by regulating and monitoring their cognition, learning strategies, motivation, and engagement during the learning process (Panadero, 2017).

Adult learners also project more academic and life experiences (Gouthro, 2019). Often, they voluntarily return to higher education, are more ready to learn, and will be more engaged throughout their academic careers (Kara et al., 2019). For this reason, it has been suggested that adult learning should apply authentic problems to guide content and small group discussions (Kara et al., 2019; Mukhalalati & Taylor, 2019, Trivette et al., 2009). Studies have shown that this practice has increased motivation and subject matter retention (Loizzo et al., 2017; Major & Palmer, 2001; Ro & Song, 2019). For this reason, dental education should embrace a learning approach that emphasizes learning (that which the student performs) over teaching (that which the faculty member conducts). The traditional lecture-based curriculum does not support integrating basic and clinical sciences and keeps students in a passive learning position (Al-Madi et al., 2018; Jurado et al., 2021). This makes applying acquired knowledge difficult in clinical settings. Based on these findings, implementing elements of adult learning to address the inadequacies of the lecture-based curriculum in dental education supports the implementation of CBL and PBL within the dental curriculum.

Framework for Noncognitive Factors and Academic Performance

Farrington et al. (2012a) systematically reviewed a theoretical framework for understanding noncognitive variables and student GPA among college and K-12 students. According to this framework, five types of noncognitive factors exist. The first addresses academic behaviors typically associated with coursework engagement. These include consistent class attendance and participation, completing homework assignments, and studying. The second is academic perseverance. These attributes illustrate a student's ability to thrive despite obstacles or challenges. Academic perseverance variables include a student's grit, self-discipline, and self-control. The third factor relates to a student's academic mindset or belief in oneself, especially regarding his or her education. Central to this category is self-efficacy, ability to improve, sense of belonging, and a student's connection of schoolwork to his or her life. The fourth is the application of learning strategies. Learning strategies are processes that help students think, remember, and learn. This includes the student's study skills, metacognitive strategy, time management, and setting achievable goals. The final noncognitive factor type is the students' social skills, or their ability to communicate and engage with their faculty and peers. This can include interpersonal skills, empathy, cooperation, responsibility.

According to Farrington et al. (2012a), promoting and strengthening noncognitive factors can help students develop positive mindsets. They propose that academic mindsets directly affect the other four noncognitive factors. Basically, "Positive academic mindsets motivate students to persist at schoolwork (i.e., they give rise to academic perseverance), which manifests itself through better academic behaviors, which lead to improved performance in school" (Farrington et al., 2012b). Furthermore, academic behaviors explain the connection

between academic mindsets, social skills, academic perseverance, learning strategies, and academic performance. This relationship demonstrates that noncognitive factors are influential only within the socio-cultural context where learning occurs.

Of the five types of noncognitive variables that Farrington et al. (2012a) analyzed in their literature review, they found strong evidence that academic behaviors, academic mindsets, and learning strategies positively affect students' grades in college and K-12 settings. According to their qualitative research, academic behaviors are the "most proximal noncognitive factors to student academic performance" (Farrington et al., 2012a, p. 19) as all other noncognitive factors are related to and can be affected by them. Furthermore, their research suggests a strong correlation between improving academic behaviors and improving academic performance, as evidenced by course grades. Similarly, Farrington et al. (2012a) discovered strong evidence in the literature that academic mindsets also affect student performance. Research from school- to college-age students indicated that those who engaged in growth mindset activities resulted in stronger, more positive mindsets. As a result, they were "more likely to engage with academic work, demonstrate positive academic behaviors, and persist despite setbacks" (Farrington et al., 2012a, p. 38). Furthermore, evidence suggests that applying appropriate learning strategies positively affects academic behaviors. As discussed by Farrington et al. (2012a), "students are likely to spend more time studying, doing homework, and coming to class if they feel that engaging in such behaviors will lead to academic success" (p. 47).

The findings for academic perseverance were inconclusive as many existing studies often combine persevering tendencies with those related to academic behaviors such as grit and self-control. As summarized by Farrington et al. (2012a), studies conducted at the University of Pennsylvania ($r = 0.34$) and West Point ($r = 0.06$) demonstrate that while grit produced a

significant correlation with students' grades at the time of reporting, this does not indicate that it would be a strong a predictor of future academic performance. While the study conducted at the University of Pennsylvania is statistically significant, scores from West Point indicates almost no relationship at all. These mixed results suggest that further research should be conducted on grit as it relates to academic behaviors and students' academic performance.

Studies conducted with eighth-grade students about self-control as an academic behavior and grades at a magnet school (r = 0.55 to 0.67) and West Point (r = 0.13) revealed a stronger correlation (Farrington et al., 2012a). However, Farrington et al. (2012a) consistently suggested that studies demonstrating significant correlations between grit or self-control and students' grades are stronger when both dependent and independent variables are measured concurrently, or grit is measured prior to students being fully emersed in their course work. This suggests that further research should be conducted to address these limitations by combining predictor variables. Social skills were shown to exhibit the weakest relationship with student grades. According to Farrington et al. (2012a), "35 studies that included academic achievement measures, [social and emotional] interventions produced an average effect size of 0.33 on student grades and 0.27 on achievement test scores, the latter translating to a percentile difference of 11 percent" (p. 48). They further suggested that any effect discovered was apparently indirect. Furthermore, most studies focused on learner populations younger than high school- or college-aged students. This indicates that while noncognitive variables may affect academic performance, some types of factors appear to be more productive than others.

Related Literature

This study aims to determine the potential predictive relationship between students' noncognitive variables that may affect learning and self-directed learning academic performance.

This portion of the literature review provides an overview of self-directed, case-based, and problem-based learning and examines how they relate to dental education. Then current cognitive measures of academic success, such as GPA and student test scores, are discussed. An overview of noncognitive variables and current measures will be addressed before a detailed review of motivation, self-regulation, autonomous functioning, learning strategies, and grit is given. Each noncognitive variable listed will be discussed first as an overview, then related to SDL, CBL, and PBL.

Self-Directed Learning

While dental school curriculum reform efforts continue, there is a need to ascertain effective self-directed learning methods to increase critical thinking and practical application skills (Deshpande et al., 2019). Many studies have considered self-direction in adult learning and emphasize the individual's responsibility in the learning process (e.g., Brockett, 2018; Hiemstra, 2013; Poole, 2012; Pryce-Miller & Serrant, 2019).

> "In its broadest meaning, [self-directed learning] SDL describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975).

SDL elicits greater active student participation in one's education by regulating and monitoring his or her cognition, learning strategies, motivation, and engagement during the learning process (Panadero, 2017). Aligned to SDL, adult learners should demonstrate higher-level thinking processes such as planning, monitoring, and controlling their learning and

reflection. However, these processes are rarely present in the traditional lecture setting pervasive in dental curricula delivery (Deshpande et al., 2019).

There are three primary goals of SDL (Leary et al., 2019). The first goal is to promote the growth of learners to be self-determined in their studies. This posits that learning should be self-initiated, based on a sense of curiosity and discovery from the individual (Zhu et al., 2020). The second goal of SDL is to promote transformational learning. Similarly, the third goal is to foster emancipatory learning and social action (Leary et al., 2019). For SDL to be successful, critical reflection from the learner must occur (Zhu et al., 2020). As suggested by the SCLT, critical reflection allows learners to "self-regulate their cognitions, emotions, behaviors, and environments" (Schunk, 2020). It catalyzes learners to implement a reflective judgmental process necessary to gain competence and mastery (Leary et al., 2019; Zhu et al., 2020).

Furthermore, the Commission on Dental Accreditation (2019) advocated for "dental education programs [to] develop graduates who have the capacity for life-long and self-directed learning and are capable of providing evidence-based care to meet the needs of their patients and of society." It has been suggested that dental schools should provide students with frequent opportunities to apply reflective judgment processes during their learning encounters (Field et al., 2020). This can include simulations where students are presented with common and rare problems inherent to dental practices (Chowaniec et al., 2018; Deshpande et al., 2019). This "learn by doing" technique requires them to think and reflect on their past learning to find solutions critically (Zhu et al., 2020). Evidence suggests that this more active learner role promotes SDL skills better than traditional lecture-based curricula (Zhu et al., 2020). Two current paradigms are case-based learning and problem-based learning (Watkins, n.d.).

Case-Based and Project-Based Learning

Lecture-based instruction is still the preferred method of instruction in dental schools (Abdelsalam et al., 2020). This teaching method allows for faculty and student interaction while addressing more topics quicker (Gürsoy et al., 2018). Unfortunately, it situates students in a more passive learning role which does not align with the current accreditation standards and competency statements (Abdelsalam et al., 2020). To satisfy these expectations, dental school curricula should balance students' SDL with content retention (Abdelsalam et al., 2020; Leary et al., 2019; Zhu et al., 2020). Two paradigms currently implementing SDL skills in dental education are case-based learning (CBL) and problem-based learning (PBL) (Watkins, n.d.). Simply stated, PBL does not require students to possess any prior experience or understanding of the subject matter, whereas CBL requires applying students' prior knowledge to solve the problem (Watkins, n.d.).

PBL was first implemented in medical schools in 1969 when McMaster University incorporated it into its curriculum (Servant-Miklos, 2019). Since then, it has been incorporated into several medical schools worldwide and is supported by the World Federation of Medical Education and the World Health Organization (Neville et al., 2019; Servant-Miklos, 2019; Yongxi & Jianyi, 2021). Furthermore, PBL has become the focus of curriculum reformers in dental and medical education (Deshpande et al., 2019). There are five primary goals in PBL (Razali et al., 2018; Servant-Miklos, 2019). These include helping students construct an extensive and adaptable knowledge base, becoming strong collaborators, developing problem-solving skills, boosting intrinsic motivation, and promoting self-directed learning skills (Razali et al., 2018). The core concept behind PBL is activating prior knowledge, which helps the subsequent processing of new information (Razali et al., 2018). The retention of subject matter

and the ability to employ it is improved when students exercise the opportunity to elaborate on the knowledge at the time of learning (Shunk, 2020). Similarly, Moust et al. (2019) described PBL as a form of education where information is mastered within the same context that it was learned.

Case-based learning (CBL) is a method of instruction where students apply their knowledge to authentic scenarios with the goal of promoting higher levels of cognition (Yale Poorvu Center for Teaching and Learning, 2020). CBL encourages critical thinking and inquiry-based methods to prepare students for clinical practice (Yale Poorvu Center for Teaching and Learning, 2020). By applying real clinical cases, this style of pedagogy connects theory to practice by focusing student attention on presented scenarios and requiring students to work through them as if they were clinicians (Macpherson et al., 2021). In alignment with the adult learning theory, CBL encourages learning through students' application of knowledge by increasing the relevance of their learning (Thistlethwaite et al., 2012). Furthermore, SCLT suggests that students learn through interactions with their peers and environment (Schunk, 2020). CBL provides an inquisitive learning environment where students work collaboratively (Yale Poorvu Center for Teaching and Learning, 2020). Should students be unable to perform, they look to their peers for the necessary actions to complete a task and produce similar results (Schunk, 2020).

CBL and PBL promote student learning by requiring them to develop their own resolutions to problems and content (Yale Poorvu Center for Teaching and Learning, 2020). In turn, this further develops their critical thinking skills and content application in clinical settings (Macpherson et al., 2021). They also help develop reflective thinking and conceptual understanding, which supports a more profound learning approach (Zhu et al., 2020).

Furthermore, this style of instruction has met the challenges of creating an integrated curriculum based on multidisciplinary modules, blends the basic science knowledge with clinical applications, and promotes a learning environment that fosters self-directed learning and critical thinking skills (Watkins, n.d.).

Cognitive Variables

Traditionally, students' undergraduate GPA and performance on standardized tests, such as the Dental Admissions Test (DAT) and Perceptual Ability Test (PAT), have been applied to anticipate their success in dental programs (Cho & Serrano, 2020; Schneider & Preckel, 2017; Virtue et al., 2017). While many studies have examined the predictive power of undergraduate GPA, there have been numerous inconsistencies. A longitudinal study conducted at the Schulich School of Medicine and Dentistry at the University of Western Ontario, Canada, supported the notion that undergraduate GPA was a positive indicator of student success in dental school. In this study, Plouffe et al. (2018) established two stability categories based on GPA percentage cut-offs across dental school courses. The low performing group, whose GPA ranged from mid- to high-70s, and the high-performance group whose GPA calculations resulted in scores in the mid-80s range (Plouffe et al., 2018). Their findings revealed that as undergraduate GPA increased, so too did the probability of students performing well across each year of dental school.

> Notably, when students' pre-dental GPA and DAT chemistry scores were approximately two points below the mean, the probability of belonging to each stability category was roughly equal. When pre-dental GPA and DAT scores decreased at least three points below the mean, the probability of remaining stable in the low-performance group across

> each year increased the most, and the probability of remaining stable in the high-performance group decreased the most. (Plouffe et al., 2018, p. 521).

Similarly, Lee et al. (2108) examined the relationship between undergraduate performance (GPA and DAT scores) and the Comprehensive Basic Science Examination (CBSE) scores, the entrance examination for oral and maxillofacial surgery programs. Student performance on the DAT Perceptual Ability (PAT) test positively correlated (r=0.38, p=0.01) with performance on the CBSE.

Contrary to these findings, Carroll and Schuster (2015) found that neither the PAT nor any DAT components significantly predict students' clinical performance (model R^2 ranged from 0.041 to 0.155). They suggested that students with lower undergraduate GPAs and who underperformed on admissions tests could outperform their peers who met the minimum requirements. Likewise, Rowland and Rieken (2018) also examined undergraduate GPA. While they found it to be a reliable indicator of dental school success (adjusted R^2=0.238), they suggested that focusing on undergraduate science coursework GPA and a student's emotional intelligence can help admission committee members gain a more complete predictor of dental school success. However, these data are not a reliable determining factor once students were compared with their overall class performance (≤10.8% in all categories) (Rowland & Rieken, 2018).

More closely examining undergraduate coursework and a student's chosen major is another way admission committees filter through their applicants. Park et al. (2018) found that students who participated in the biomedical science coursework at Boston University had a significant positive correlation between undergraduate GPA, GRE test scores, and academic performance in their first year of doctoral study (undergraduate institutions aOR= 1.76; GPA

aOR=8.96; Quantitative GRE: crude OR=1.04; Verbal GRE crude OR=1.02). Park et al. (2018) implemented descriptive statistics and ordinal logistic regression models on admission variables to calculate undergraduate institution rigor and normalize GPA universally to verify these results. Furthermore, Davies et al. (2020) demonstrated that more rigorous curricula better prepared students for dental school, despite successfully completing science courses. Findings included, "students with DAT scores over 20 academic average (p = 0.001), 18 total science average (p = 0.001) and 22 reading comprehension (p = 0.004) performed better in dental school courses" (Davies et al., 2020). Students who participate in predental programs, such as Boston University Schools of Medicine and Dental Medicine Oral Health Sciences Master's program and received a final grade of B+ or higher in their physiology and biochemistry courses, were more successful at enrolling in a dental program with a matriculation rate of 94% for the cohort (Davies et al., 2020). While this suggests that students who originate from average to more rigorous undergraduate programs will perform better while enrolled, Davies et al. (2020) also found no statically significant variance in overall performance when compared to their peers (p = 0.036). The idea that students from a science background are better prepared for a dental program has long been accepted (Robertson et al., 2020). However, Price and Park (2018) found that an undergraduate science major or even a greater student focus in sciences courses did not significantly affect performance at the predoctoral level (see Appendix G). Additionally, they found that a double major, doubling the rigor of undergraduate coursework, was also an insufficient predictor of academic success (Price & Park, 2018). The researchers contended this with no evidence provided.

Typically, prospective students should maintain sufficient passing scores on standardized tests to be admitted to a dental program (Virtue et al., 2017). While some schools still consider

GRE scores a component of their admissions process, studies have demonstrated a weak correlation between GRE scores and academic success in doctoral programs. Hall et al.'s (2017) study demonstrated no statistical difference regarding quantitative GRE score, verbal GRE score, writing GRE score, and GPA. Park et al.'s (2018) study revealed that "GRE scores were mildly contributory in univariate analysis but did not remain significant in the adjusted model (Quantitative GRE: crude OR 1.04; Verbal GRE crude OR 1.02)." To date, most dental schools no longer consider the GRE as a prerequisite of their admissions process (Virtue et al., 2017). Since 1950, the DAT has helped dental school admissions committees select optimal candidates (Novack & Turgeon, 2020). The DAT is a standardized exam that measures dental school applicants' general academic ability, scientific information in biology, general chemistry, organic chemistry, quantitative reasoning, reading comprehension, and perceptual ability (American Dental Association [ADA], 2021). While there is no established pass/fail grade for the DAT, out of a maximum score of 30, a score of 19 in each section is considered average, while a score of 21 or more will rank a student in the top 10% of those who completed the test (ADA, 2021). Several studies have examined the administration of the DAT as a positive indicator for dental school success (Carroll & Schuster, 2015; Davies et al., 2020; Plouffe et al., 2018). While Plouffe et al. (2018) contended that a student's chemistry test sub-score was a positive predictor of dental school success, it did not predict a student's clinical performance. Davies et al. (2020) found that "students with academic average DAT scores of 20 and above ($p < 0.001$), total science 18 and above average ($p < 0.001$) and reading comprehension 22 and above ($p = 0.004$) performed better in both dental school courses and overall in the [Oral Health Sciences] master's program as measured by OHS GPA."

Noncognitive Variables

William Sedlacek has extensively studied noncognitive variables to address admissions inequalities for underrepresented students. According to Sedlacek (2011), noncognitive variables "refer to variables relating to adjustment, motivation, and perception." Initially, Sedlacek (2011) identified eight noncognitive variables. These include positive self-concept, realistic self-appraisal, understanding of the system, prefer long-range to short-term or immediate needs, availability of a strong support person, successful leadership experience, and demonstrated community service (Sedlacek, 2011). These variables combine personal and social aspects with psychological attributes such as a student's motivation, flexibility, and perceptions (Sedlacek, 2011). Noncognitive variables help ascertain all students' abilities as standardized tests, and prior grades may afford only a limited scope of their potential (Farrugia et al., 2018).

In dental education, noncognitive factors are qualitative data points typically implemented during the admissions process (Price & Park, 2018). These can include interviews, letters of recommendation, and emotional intelligence assessments (Price & Park, 2018; Wilson et al., 2014). If candidates pass the initial screening process, a series of interviews and investigations occur (Price & Park, 2018). These noncognitive factors help admission committee members better understand the students personally (Price & Park, 2018). However, a study conducted at the University of Ottawa Medical School determined that there is no clear correlation between noncognitive factors and academic performance (Zs > 4, ps < .001) (Bowman et al., 2019).

One of the more studied noncognitive elements is the interview process (McAndrew et al., 2017; Plouffe et al., 2018; Price & Park, 2018). It is suggested that evaluating interview scores can help admission committees better assess a candidate's "communication interpersonal

skills, resiliency, and integrity" (Plouffe et al., 2018). However, since 1989, this practice has been consistently criticized and shown to be ineffective in the literature (Roberts & Porter, 1989; McAndrew et al., 2017). Chow and Milos (2019) sought to determine if students' interview scores predicted their success in a dental hygiene program. Their results showed no correlation between interview scores and students' academic performance *(*R = -0.07, $P \leq 0.05$*).* In Their Study, McAndrew et al. (2017) sought to determine if the interview method (multiple mini-interviews versus Newcastle's traditional interview method) predicted academic performance as demonstrated by examination scores of dental students. Two exams were administered for this study - the BDS part 1 measuring anatomy, physiology, and biochemistry, and BDS part 2 that examined oral ecosystems and clinical dentistry. Like Chow and Milos (2019), they determined that there was no correlation between academic performance and interview scores (BDS 1: r = -0.011, p= 0.06; BDS 2: r = -0.009, p = 0.03). Moreover, Puddey and Mercer (2014) investigated whether interviews that focused on communication skills could predict performance in Australian medical education. Results demonstrated no significant correlation until students reached the clinical levels of their education (Level 5: r = 0.172, p = 0.003; Level 6: r = 0.120, p = 0.032).

Measures of Noncognitive Variables

Since its inception, the study of noncognitive variables has developed to include more noncognitive variables from the original eight. Based on Farrington et al.'s (2012) framework for noncognitive factors and academic performance**,** this review will focus on *self-regulation, intrinsic motivation, autonomous functioning, learning strategies,* and *grit*. Self-regulation includes self-motivation and volitional regulation (Valenzuela et al., 2020). In other words, it is the degree of a person's motivation to perform a particular behavior autonomously or in a

relatively controlled manner (Inzlicht et al., 2021). Intrinsic motivation includes a students' curiosity, ability to overcome new tasks, and collaboration skills (Whitehead, 1984). It produces the power to strengthen an individual's determination to satisfy needs while resolving conflicts (Schunk, 2020).

Autonomous functioning can be described as "the need to self-regulate one's experiences and actions, entailing a form of functioning associated with feeling volitional, congruent, and integrated" (Ryan & Deci, 2017). Learning strategies are cognitive plans oriented toward successful task performance (Schunk, 2020). In the process of learning, the student selects necessary learning strategies to help achieve learning goals. His or her ability to do so determines the level of self-regulated learning. Matcha et al. (2019) found that students who engaged in various learning tactics performed better (N = 198, 17.44%). Grit can be defined as the "perseverance and passion for long term goals" (Duckworth et al., 2007). It is a person's ability to work towards a challenging goal while sustaining effort over long periods (Duckworth & Yeager, 2015). Each variable will be discussed in-depth.

Motivation

A core concept of self-directed learning is motivation, as it influences the degree to which a person employs self-regulation, autonomous functioning, learning strategies, and grit. In the literature, motivational abilities are considered critical in academic achievement (Kroner et al., 2017). Early research regarding motivation concerning SDL suggests that intrinsically motivated individuals were more likely to engage in learning encounters such as PBL and CBL to explore their interests (Deci & Ryan, 1985; Schmidt, 1983). Further research suggests that these theories of motivation are more involved when discussed in PBL and CBL literature (Cho, 2019; Jaegle et al., 2019; Schweder & Raufield, 2021). The self-determination theory posits that

two main types of motivation, intrinsic and extrinsic motivation, shape students' behaviors (Deci & Ryan, 2008). Furthermore, a continuum was established that illustrates the level of students' motivation and helps educators anticipate expecting behaviors (Deci & Ryan, 2008).

Intrinsic and Extrinsic Motivation. Whitehead (1984) defined *extrinsic motivating factors* as the pressures exerted on students via their social networks, which students perceive as the main reward from education, and reinforcements they might receive. Ryan and Deci (2020) suggested that extrinsic motivation is the student's determination to behave in certain ways based on external sources and rewards, thus making extrinsic motivation unique to each person. Since these students perceive education as a means to an end, they are less likely to engage in SDL and do not attempt to achieve more than is necessary to achieve their goals (Aktaş & Sancar, 2021).

Conversely, autonomous or relatively controlled, intrinsic motivation involves students' curiosity, ability to overcome new tasks, and collaboration skills (Ryan & Deci, 2020). Research has shown that intrinsically motivated students are more likely to engage in SDL rather than extrinsically motivated students ($\chi 2(1) = 5.07$, $p > .001$) (Schweder & Raufield, 2021). As some studies have shown, a student's curiosity about a topic typically leads to deeper learning (Jaegle et al., 2019). Additionally, a student's interest, choice, or perceived value of the task also increases his or her intrinsic motivation (Heindle, 2018; Jaegle et al., 2019). In their study, Bonk and Lee (2017) surveyed participants to examine learning preferences, goals, and motivations behind self-directed online learning. Based on participant responses, trends noted by the researchers revealed that students who maintained greater intrinsic motivation engaged with the content more, resulting in more significant self-efficacy. Moreover, they noted that students who maintained greater self-efficacy possessed a dramatic increase in their intrinsic motivations (Bonk & Lee, 2017). This research suggested that intrinsic and extrinsic motivation are linearly

opposed (Ryan & Deci, 2020). Inherently, intrinsic motivation catalyzes students' behavior in keeping with their own goals and expectations. In contrast, extrinsic motivation promotes conformity to the standards of others, such as parents, peers, and educational institutions (Deci & Ryan, 2008).

Self-Determination Continuum. Motivation can be situated on a continuum that ranges from autonomous motivation to controlled motivation (Ryan & Deci, 2008). Autonomous motivation can be influenced by both intrinsic and extrinsic factors as long it aligns with students' sense of self (Ryan & Deci, 2008). Controlled motivation only involves extrinsic motivation, or a desire for rewards or fear of punishment (Ryan & Deci, 2008). The more a student is autonomously motivated, the more self-directed he or she will become. On the other hand, students who exhibit more controlled motivation behave in response to pressures they feel, resulting in little to no autonomy (Ryan & Deci, 2008).

Moreover, Ryan and Deci (1985) identified three basic needs that determine behavior. These include the need for autonomy, competency, and relatedness (Ryan & Deci, 2008). Autonomy is a person's need to have a sense of control over his or her choices, life, and ultimately, behaviors (Schneider et al., 2018). Deci and Ryan (2012) suggested a correlation between autonomy, task engagement, and perceived competence. Furthermore, presenting students with choice increases a learner's perception of autonomy and intrinsic motivation and decreases their perception of external regulation (Deci & Ryan, 2012). Schneider et al. (2018) conducted a study that explored students' perceived autonomy and found that students who were given a choice (M= 4.56, SD= 1.14) demonstrated higher scores than students with no choice (M= 3.26, SD= 1.03). Furthermore, Schneider et al. (2018) suggested that the inclusion of autonomy-enhancing features in a curriculum has increased students' self-determination and, in

turn, his or her intrinsic motivation. Competency addresses the need of individuals to gain mastery of tasks and learn different skills that are important to them (Deci & Ryan, 2000). This related to the ability to achieve and to gain and master knowledge and skills that help them succeed in completing tasks that are important to them (Deci & Ryan, 2012). Relatedness is the need to experience a sense of belonging and connection with others (Deci & Ryan, 2008). According to Ryan and Deci (2000) where a person is situated on the continuum determines his or her ability to satisfy these needs. This results in a manner of motivation that can be measured by quality rather than the quantity of the motivation experienced (Ryan & Deci (2000).

Motivation and Self-Directed Learning. *Self-directed learning* can be defined as "a process in which individuals take the initiative, with or without the help from others, in diagnosing their learning needs, formulating goals, identifying human and material resources, choosing and implementing appropriate learning strategies, and evaluating outcomes" (Knowles, 1975). As such, there is a strong emphasis on student choice, and learners need to feel empowered to make decisions regarding their learning (Gandomkar & Sandars, 2018). Research has suggested that intrinsic motivation is a critical component of self-directed learning (Zhu et al., 2020). Extrinsic motivating factors relate to the external pressures that students perceive in completing a task (Schunk, 2020). Since these students perceive education as a means to an end, they are less likely to engage in SDL (Aktaş & Sancar, 2021). On the other hand, intrinsic motivation includes students' curiosity, ability to overcome new tasks, and collaboration skills, all of which are key components of SDL (Heindle, 2018; Jaegle et al., 2019; Sumuer, 2018). Research has shown that intrinsically motivated students are more likely to engage in SDL rather than extrinsically motivated students ($\chi 2(1) = 5.07$, $p > .001$) (Schweder & Raufield, 2021). It has been suggested that providing students with choice increases students' intrinsic motivation.

Jeno et al. (2018) examined if student choice when employing a mobile application versus a textbook resulted in greater feelings of competence, autonomy, and intrinsic motivation (see Table 1).

Patall et al. (2018) suggested that the typical classroom's highly restrictive environment might diminish students' motivation to learn due to significant demands such as deadlines and limited resources. However, the more informal learning environment typical of SDL provides students with more choices, which, in turn, should boost intrinsic motivation (Jaegle et al., 2019; Schweder & Raufield, 2021).

Table 1

Mean Comparison Between the Study Conditions Along with Standard Deviations, F-*Values and Effect Sizes (Cohen's d)*

	Mobile application (n=29)	Textbook (n = 29)		
	M (*SD*)	*M* (*SD*)	*F*(1,57)	*D*
Perceived autonomy	6.14 (0.92)	3.22 (1.41)	86.87*	2.45
Perceived competence	3.58 (1.07)	2.23 (1.0)	24.62*	1.30
Intrinsic Motivation	6.05 (0.69)	2.65 (1.08)	202.54*	3.75
Achievement	9.48 (3.42)	8.0 (4.37)	2.06	0.38

*Note: *sig p < .001.* Table adapted from *The effects of m-learning on motivation, achievement and well-being: A Self-Determination Theory approach,* by Jeno et al. (2018), p. 676

Motivation, PBL, and CBL. Rotgans and Schmidt (2019) conducted a systemic review that revealed that while studies investigating motivation and PBL are limited, their results are difficult to generalize. This is due to inconsistent methodologies, definitions, and parameters. Common understanding includes that PBL and CBL rely on students engaging with the learning process (Frati, 2020). Nevertheless, the challenge remains in finding methods that motivate students to become more active learners (Watkins, n.d.).

Typically, in a CBL and PBL setting, students are presented with a problem comprising one or more phenomena needing a resolution or explanation (Fukuzawa et al., 2017). While reviewing the problem, students activate their prior knowledge (e.g., what is already known about the topic) and develop hypotheses that can resolve it. While developing hypotheses, gaps in student knowledge become apparent. Students are, then, responsible for remediating these gaps through self-study and self-directed learning. This problem-solving process can positively affect student motivation (Rotgans & Schmidt, 2019).

Another characteristic of CBL and PBL is that learning does not occur in isolation but typically in a group setting (Ali, 2019). As SCLT suggests, learning is a social phenomenon wherein peers seek each other for guidance on acceptable behaviors. CBL and PBL promote collaboration skills to analyze options and facilitate decisions on the research to conduct and how to proceed. In this environment, students assume more responsibility for acquiring their academic and social skills, boosting their self-efficacy (Shin, 2018). According to Bandura (1997), students with a strong sense of self-efficacy are more likely to become engaged in a task and accept any challenges or disappointments. Therefore, students' academic self-efficacy is important in their motivation to achieve (Zimmerman, 2000).

The adult learning theory suggests that tasks that apply to the students' goals are valued more by students, thus improving their intrinsic motivation (Gouthro, 2019; Lavy, 2020). According to Chaudhuri (2020), intrinsically motivated students are interested in the course content, persist despite difficulties and challenges, and are more willing to seek out knowledge independently. Additionally, curiosity strongly influences their learning, which encourages them to ask questions to seek deeper understanding (Wade & Kidd, 2019). When adult learners see a gap between their preexisting knowledge and what they wish to know, they exert more effort in a chosen task (Wade & Kidd, 2019). PBL and CBL can promote learning encounters that allow this natural curiosity and desire for greater knowledge to flourish (Jaegle et al., 2019).

Another method for boosting motivation in SDL is to implement technology-facilitated PBL and CBL. More recent research explores how technology-enhanced learning can be developed to increase student motivation and improve engagement (Becker et al., 2017; Heflin et al., 2017; Heindle & Nader, 2018; Kennedy & Dunn, 2018). Oudeyer et al. (2016) suggested implementing informationally engaging technology, aesthetically appealing, and providing adequate resources with the right level of complexity. This, combined with a new style of learning, such as PBL and CBL, presents students with the novelty and element of surprise that has also been shown to increase student motivation (Jaegle et al., 2019). Heindle (2018) discussed how an inquiry-based assignment, such as PBL and CBL, could also bridge this gap. These assignments improve student motivation and self-efficacy as they have control over their learning while faculty take a lesser role and only must provide the resources necessary to complete the assignment (Becker et al., 2017; Heindle & Nader, 2018).

Self-regulation

The Commission on Dental Accreditation (2019) advocates for "dental education programs [to] develop graduates who have the capacity for life-long and self-directed learning and are capable of providing evidence-based care to meet the needs of their patients and of society." Self-regulated learning (SRL) refers to "cognitive, metacognitive, motivational, and affective processes that learners use to systematically focus their thoughts, feelings, and actions on the attainment of their learning goals" (Schunk, 2020). SRL posits that a person's motivational beliefs influence how they choose to employ self-regulatory strategies during learning (Barati et al., 2018; Ngwira et al., 2018). Likewise, Sergis et al. (2018) described self-regulatory learning as the "concept of motivation and aims to describe the inner 'needs' of students that may affect their experiences and performance in the learning process." These definitions suggest a strong emphasis on an individual's voluntary actions and choices that make them capable of controlling and enhancing their school life to meet their needs (Wehmeyer, 2005).

In literature, there are many theories regarding self-regulated learning, but there are common assumptions. First, it requires students to be involved in their learning and performance (Oates, 2019). Consequently, they should assume control of their learning by building and applying knowledge unique to them (Schunk, 2020). This knowledge is then applied to develop goals, plans, and the steps necessary to satisfy the individual's inner needs (Schunk, 2020). The second assumption is that self-regulated learning is a dynamic and cyclical process of feedback. Highly self-regulated learners set their own goals, monitor their progress, and adapt in response to challenges (Oates, 2019). A third assumption is that goal setting triggers self-regulated

learning by requiring individuals to focus on goal-directed activities and apply relevant strategies to accomplish them (Oates, 2019).

Processes like goal setting, self-efficacy, and outcome expectations are considered motivational variables that affect self-regulated learning (Schunk, 2020). In turn, successful self-regulated learning motivates learners to set new goals and continue learning, creating a cyclical process (Oates, 2019). Three self-management strategies have been identified that individuals employ to regulate their motivation for learning (Zhu et at., 2020). These include self-observation, self-assessment, and self-support (Schunk, 2020). These strategies are strengthened through observing others and implementing learning strategies needed to solve challenges (Barati et al., 2018). Other motivational variables involved in self-regulated learning include values, goal orientations, self-schemas, and help-seeking (Schunk, 2020).

Self-Determination Theory. Self-regulatory learning has often been discussed in conjunction with the self-determination theory (SDT) (Ryan & Deci, 2020). According to Deci and Ryan (2000), this theory promotes two fundamental claims. First, different types of behavioral regulation, or motivational styles, are dependent on autonomous functioning. The functioning continuum to measure this ranges from low (external, introjected regulation) to high (identified regulation and intrinsic regulation) (Ryan & Deci, 2020). The highest level of behavioral regulation is intrinsic motivation, or the idea that an individual engages in exciting and enjoyable activities (Jaegle et al., 2019). Identified regulation is the second level whereby individuals will engage in activities that they find to be personally important (Hsu et al., 2019). Like the adult learning theory, students who find learning experiences that are applicable and important to their goals are more likely to engage in the activity and assume responsibility for their learning (Gouthro, 2019; Lavy, 2020). The two other forms of regulation styles, introjected

and external, are less self-determined (Howard et al., 2021). Individuals who relate to introjected regulation complete activities mainly because they feel internal pressure, such as shame or guilt, to complete a task (Howard et al., 2021. The least self-determined motivational style is external regulation or individuals who respond to external forces such as rewards or punishments (Hsu et al., 2019).

Self-Regulation and Self-Directed Learning. Literature commonly applies self-regulated learning and self-directed learning synonymously (Husmann et al., 2018). While they share some common characteristics, there are some distinctions between them (Husmann et al., 2018). Most notably, self-regulated learning and self-directed learning can be considered a method of instruction, a design feature of the learning environment, and a learner characteristic (Husmann et al., 2018). Based on its adult learning theory background, self-directed learning is considered in broader terms than self-regulated learning. It is considered both a method of instruction and a learner characteristic (du Toit-Brits, 2018). A self-directed learning environment promotes skills and tendencies that students can master and apply to other learning encounters to meet adult student needs (Merriam, 2018). According to du Toit-Brits (2018), learning tasks in self-directed learning are designed by the students. This is aligned to problem-based learning, where the students generate and solve a problem with little to no faculty guidance (Watkins, n.d.).

On the other hand, self-regulated learning has consistently been studied in the context of learner characteristics and refers to learners planning, monitoring, and controlling their learning to maximize educational benefits (Veenman 2017; Wong et al., 2019). This theory is based on the idea learners maintain control over their education and can regulate their behaviors to achieve goals (Dignath & Veenman, 2021). There are many similarities between self-regulated learning

and self-directed learning. First, they involve active engagement, goal-directed behaviors, reflection, and monitoring (Husmann et al., 2018). Furthermore, a plan must be established that guides individuals towards their goals (Dignath & Veenman, 2021). This activates an individual's metacognitive skills necessary for goal setting, establishing a plan, and monitoring progress (Schunk, 2020). Another similarity is the strong emphasis on intrinsic motivation. Research suggests that self-regulated learning and self-directed learning could not occur without this component (Eom, 2019).

Self-Regulation and CBL and PBL. Studies have shown that faculty who support autonomous functioning within their curriculum support greater student satisfaction ($\Delta = + 1.00$, $t = 38.50$, $p < .001$, Cheon et al., 2020) (Wilks's $\lambda = .73$, $F(5,83) = 6.00$, $p < .001$, De Muynck, 2017). Studies have shown that both students and faculty feel that PBL promotes the development of self-directed learning tendencies (Ngereja et al., 2020). According to Ngeraja et al. (2020) results were as follows:

> 69% of all students in both samples agreed or strongly agreed that the project-based assignment enabled them to gain an in-depth understanding of project management concepts, 71% of students agreed or strongly agreed that the assignment provided them with an opportunity to relate better to the project management concepts, 92% of students agreed or strongly agreed that the assignment enabled them to recognize the triple tasks of digitalization projects, and 64% of students agreed or strongly agreed that the assignment provided them with an authentic learning experience.

In their review of PBL in medical education literature, Stentoft (2019) posited that PBL might help students develop metacognitive competencies via collaboration and promote skills necessary for medical research. Furthermore, Pu et al. (2019)'s study demonstrated that case- and

problem-based learning encounters encourage students to think critically, cope with challenges, promote self-efficacy, and facilitate reflection processes (see Table 2).

However, studies revealed that self-regulated learning is a developing process (Ma & Lu, 2019; Yeo & Chang, 2017). Essentially first-year students who engaged in self-regulated learning were intimidated by having to answer to their peers and teachers and sought teacher guidance and approval (Ma & Lu, 2019; Yeo & Chang, 2017). However, both studies highlighted a trend that more senior students no longer sought this support and were more successful in employing learning strategies to meet their needs (Ma & Lu, 2019; Yeo & Chang, 2017).

Table 2

*Pearson Correlation Coefficients Between CT Disposition and PBL Performance Calculated Using Parametric Bivariate Correlation Analysis (*n *= 102).*

Removed to comply with copyright, refer to Pu, D., Ni, J., Song, D., Zhang, W., Wang, Y., Wu, L., ... & Wang, Y. (2019). Influence of critical thinking disposition on the learning efficiency of problem-based learning in undergraduate medical students. *BMC medical education*, *19*(1), 1-8.

Autonomous Functioning

Dental education focuses on creating individuals who demonstrate critical thinking abilities and independence in thought and action (CODA, 2019). One way to accomplish this is to foster student autonomy in the classroom (Ryan & Deci, 2017). The literature reveals multiple meanings of learner autonomy. The first was described by Knowles (1975) as the ability to learn independently. The next, explored by Tough (1979) and Knowles (1975), is the ability to be

responsible for one's action related to learning. Ryan and Deci (2017) described autonomous functioning as "the need to self-regulate one's experiences and actions, entailing a form of functioning associated with feeling volitional, congruent, and integrated." Simply put, *autonomy* requires learners to take the initiative and responsibility for their learning rather than the teachers (Smith & Darvis, 2017).

According to Merriam and Baumgartner (2020), three areas of autonomy need to be explored to fully understand the adult learner as an autonomous learner. The first is the pedagogical setting, or the formats, methods, and techniques implemented to address the learners' needs (Merriam & Baumgartner, 2020). According to Dole et al. (2017), the autonomous learner will assume most responsibility for planning, strategizing, and maintaining efforts throughout the learning process to ensure success. In this setting, actions customarily taken by the teacher, such as setting learning objectives and providing resources to achieve goals, are now the responsibility of the student (Dole et al., 2017; Merriam & Baumgartner, 2020).

The second area of autonomy is the teacher-learner relationship (Merriam & Baumgartner, 2020). Knowles (1970) described that traditional learning settings, such as lectures, conflict with a student's autonomous functioning. For this reason, in dental education, the relationship between teachers and students needs to be modified (Muthu et al., 2021). As with self-directed learning, teachers should function more as mentors and coaches rather than directors of knowledge (Earl, 2019). This allows the students to assume more control over their education and, in a sense, become a self-teacher (Earl, 2019). The final area of autonomy is learning activities (Merriam & Baumgartner, 2020). Knowles (1970) indicated that individuals are motivated to learn to the extent that they feel the need to know and meet goals. As such, adult education is perceived more as an internal process that is self-initiated and intrinsically

motivated (Earl, 2019). For this reason, students should assume the role of controlling their learning activities (Earl, 2019).

Research has found that schools that support student autonomy benefit students in many ways (Earl, 2019). For example, students who felt they maintained more control over their education increased their sense of wellbeing and self-esteem (Lan, 2018). There also existed a heightened sense of curiosity, persistence, and self-regulation strategies (Lan, 2018). Furthermore, students demonstrated a deeper understanding of the course concepts and improved academic achievement (Yeagear et al., 2017). One way to encourage autonomous functioning is to apply learning activities such as CBL and PBL (Suastra et al., 2019; Wijaya, 2021). These learning activities provide supportive steps necessary to promote autonomous functioning while also promoting SDL (Yeager et al., 2017).

Learning Strategies

A central element in SDL is the ability to apply learning strategies (Shaala et al., 2018). *Learning strategies* can be defined as "cognitive plans oriented toward successful task performance" (Schunk, 2020). This can include selecting and organizing information, relating the new material to prior knowledge, and maintaining a positive learning climate (Schunk, 2020). Shaala et al. (2018) advanced this notion by suggesting that learning strategies are a set of skills, including metacognition, self-regulated learning, and goal setting that support student learning. This suggests that students who apply learning strategies exert better control over the information processing aspect of learning (Shaala et al., 2018).

Learning strategies assist in encoding new information and determining the level of internal processing (Hao & Othman, 2021). Surface-level processing is defined when learners transition new information into their working memory (Schunk, 2020). This allows them to

recall information as needed, but only for a short time duration. Students who implement surface-level processing are more likely to engage in more simple learning strategies such as rehearsal and memorization (Nabizadeh et al., 2019). When learners develop connections between new information and their prior knowledge, this results in meaning and a deeper understanding of the content (Schunk, 2020). Students who utilize deep-surface processing are more likely to apply higher-level learning strategies such as elaboration, identifying patterns, and underlying content themes (Nabizadeh et al., 2019).

According to Shunk (2020), there are five identified self-regulated learning methods. These include rehearsal, elaboration, organization, monitoring, and affective (Table 3). When employing learning strategies, adult learners tend to analyze the learning goals and explore their prior knowledge first (Nabizadeh et al., 2019). This metacognitive knowledge process guides learners to determine the importance of the task, find pertinent information, and execute learning methods (Nabizadeh et al., 2019; Schunk, 2020).

The self-regulated learning methods listed in the table are specific techniques embedded within strategies to help attain goals (Schunk, 2020). Furthermore, Darling-Hammond et al. (2020) demonstrated that learning strategies and self-regulated methods are interdependent with other noncognitive factors. For example, students who employ learning strategies are more able

Table 3

Self-Regulated Learning Methods

Method	Examples
Rehearsal	Repeating information verbatim Underlining Summarizing
Elaboration	Using imagery

	Using mnemonics: acronym, sentence, narrative story, pegword, method of loci, keyword Questioning Note-taking
Organization	Using mnemonics Grouping Outlining Mapping
Monitoring	Self-questioning Rereading Checking consistencies Paraphrasing
Affective	Coping with anxiety Holding positive beliefs: self-efficacy, outcome expectancies, attitudes Creating a positive environment Managing time

Note: Table adapted from *Learning theories an educational perspective eighth edition,* by Schunk, D.H., 2020, p. 437

to self-regulate, set goals, apply study skills successfully, and use metacognitive strategies that promote learning (Darling-Hammond et al., 2020; Nabizadeh et al., 2019; Schunk & Zimmerman, 2012). Metacognitive awareness can increase proficiency, which can positively influence an individual's self-efficacy, which, in turn, can improve academic achievement (Mohamed et al., 2020). Additionally, students who display a greater sense of self-efficacy value their education and are more likely to set goals and employ self-regulatory strategies and study skills needed to achieve them (Mohamed et al., 2020; Sumuer, 2018).

CBL and PBL comprise learning environments that support learning strategy development (Ozogul, 2018; Rodriguez Mendoza, 2018). Learner control is critical in developing learning strategies and other related noncognitive variables (Earl, 2019; Merriam & Baumgartner, 2020; Lan, 2018). The student-centered nature of CBL and PBL starts with

students either being presented a problem, as in CBL, or creating their own problem, as in PBL (Watkins, n.d.). Students immediately begin addressing the problem before receiving other curriculum inputs (Ozogul, 2018). As such, they need to identify and set goals, identify prior knowledge, and employ learning strategies (Ozogul, 2018.; Rodriguez Mendoza, 2018; Watkins, n.d). They are also responsible for finding, understanding, and applying new information through materials of their choosing (Glen, 2017). All these steps are also featured in developing and supporting SDL (Yeager et al., 2017).

Grit

Duckworth et al. (2007) first introduced the concept of *grit* as the "perseverance and passion for long term goals." It requires sustaining interests over a long period of time without feedback from external sources (Tang et al., 2019). Rather, it is expected that individuals should persist regardless of distractions or deterrents that may occur (Park et al., 2020; Tang et al., 2019). Grit is a combination of persistence, perseverance, self-control, and conscientiousness (Duckworth & Quinn, 2009; Park et al., 2020; Tang et al., 2019). *Persistence* describes the ability to overcome obstacles and difficulties continually (Lechner et al., 2019). A*cademic perseverance* is the determination to achieve long-term goals, resist distractions, control behaviors, and withstand challenges related to learning (Darling-Hammond et al., 2020; Halperin & Regev, 2021). *Conscientiousness* describes a person's ability to be organized, persist, and self-reflect (Tang et al., 2019). In essence, grit is a noncognitive measure of an individual's ability to persevere in accomplishing long-term goals without stopping or shifting attention (Park et al., 2020; Tang et al., 2019).

The method by which students approach learning is as important as the content they learn (Pappano, 2013). Duckworth et al. (2007) indicated that individuals can achieve their goals

through effort and passion despite their ability levels. According to Arya and Lal (2018), a distinction can be made between students who show a high level of grit ("gritty") and those who do not ("less gritty").

> Individuals who are gritty are diligent, hard-working, maintain focus on a particular project, not affected by setbacks, while individuals who are less gritty are distracted by new ideas, may set a goal but later lose interest and pursue a different one and are unable to focus on long term tasks (Arya & Lal, 2018, p. 169).

Interestingly, fundamental traits of grit conflict with aspects of the adult learner and self-directed learning (Pemberton & McCadden, 2019). For example, andragogy suggests that adult learners are self-directed in identifying their learning goals and assessing their learning needs (Knowles, 1980). However, outside of the grit survey, a student's abilities are measured by cognitive means established by the curriculum, instructor, and educational institution (Pemberton & McCadden, 2019). Furthermore, it has been demonstrated that adult learners and SDL are more intrinsically motivated (Earl, 2019). However, grit, in general, addresses students' ability to complete external goals, such as a degree or course completion (Duckworth et al., 2007). As such, the adult learner is unable to establish his or her own goals or assess his or her own needs (Pemberton & McCadden, 2019). However, there are chances within the curriculum to embed more opportunities for self-regulation and grit to flourish (Reed & Jeremiah, 2017).

In the proper learning context, these conflicts with andragogy can be settled and characteristics of grit can be developed (Pemberton & McCadden, 2019; Reed & Jeremiah, 2017). CBL and PBL are student-driven learning scenarios that allow students to conduct meaningful research that results in goal-oriented achievement (Ali, 2019). While both scenarios can be supervised and structured, learners are granted the autonomy needed to develop their own

motivation, learning strategies, and problem-solving skills (Ali, 2019; Bailey et al., 2020; Thorsen et al., 2021). According to Al-Busaidi et al. (2021), a PBL model can include setting the stage, research questions, student investigations, research, scaffolding, collaboration, and opportunities for learning transfer, all of which foster the development of grit.

Summary

As dental education changes in purpose and format, catalyzing student success is important for the institutions and society at large. While traditional, cognitive measures such as the DAT have been implemented as academic predictors, it has resulted in an incomplete view of student's abilities. Furthermore, the application of self-directed learning experiences such as case-based and problem-based learning require more skill than can be measured cognitively. For this reason, noncognitive variables are also essential measures to examine, especially in dentistry, where practitioners are focused on problem-solving and innovation.

Studies have shown that a student's academic perseverance depends on the context and interactions with noncognitive factors (Bailey et al., 2020; Thorsen et al., 2021). Furthermore, noncognitive factors are interdependent and constantly interacting. For example, motivation determines an individual's effort towards achieving goals. Their ability to self-regulate and apply learning strategies can help determine how goals are accomplished. Students' grit is their ability to take as much time as needed to do so. Furthermore, strengthening students' autonomous functioning and repertoire of learning strategies can increase their ability to persist through challenges that may persist. Because of this, this study is designed to examine the combination of multiple noncognitive variables in an effort to better understand how they can affect student academic achievement.

CHAPTER THREE: METHODS

Overview

Chapter Three details the research design applied to explore the correlation between student noncognitive variables and student academic performance. This chapter details the research design, research questions, hypotheses, a description of participants and setting, procedures, instrumentation, and data analysis implemented for research.

Design

A predictive correlational research design was applied as the purpose of this study was to investigate the predictive relationships between students' noncognitive variables and their academic performance. As it permits a researcher to measure the magnitude and significance of relationships among several variables simultaneously, this type of research design is appropriate for this study (Creswell & Creswell, 2018; Gall et al., 2007; McMillan, 2004). Furthermore, it is commonly applied in educational research and is a stable technique considering the bivariate correlation statistic produces a small standard of error (Gall et al., 2007).

For this study, a correlational analysis will indicate if changes in the predictor variables, representing types of noncognitive variables, and criterion variable, students' self-directed learning as measured by student end-of-term Yammer grades are related. The purpose of this research is to investigate multiple variables for each participant including their self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit. As Gall et al. (2007) discussed, correlational research design is applied when a researcher wishes to collect data pertaining to multiple variables for each participant and calculate a correlational coefficient. These variables should be continuous, normally distributed, and maintain a linear relationship (Martella et al., 2013). Furthermore, this design is also helpful for understanding phenomena in

educational settings and can improve the practical application of study results (Martella et al., 2013). This study explores how multiple variables are related to students' abilities and success in dental school. Understanding these elements can assist in better understanding students' anticipated success in professional school settings. Additionally, schools create more personalized interventions based on students' unique noncognitive variable combinations.

According to Laerd Statistics (2021), predictive correlational research is employed when the researcher seeks to ascertain a potential predictive value of a variable based on the value of other variables. Variables included in this study were obtained from data gathered from a dental school located in North Carolina. The predictor variable is students' self-directed learning, as measured by students' end-of-term Yammer grades. Grades are determined by assigning a value to each student post and allows faculty to evaluate the student performance over time (Watkins, n.d.). Posts are collated weekly and graded by assigning a "relative value" to each content post (T. Watkins, personal communication, August 23, 2021).

The criterion variables represent the students' noncognitive abilities, including students' self-regulation, motivation, autonomous functioning, learning strategies, and grit. Self-regulation represents the purpose for students completing their work by measuring the four types of behavior regulation: external regulation, introjected regulation, identified regulation, and integrated regulation (Ryan & Connell, 1989). Motivation has also been cited as the catalyst for determining one's actions as it influences the degree to which a person employs self-regulation, autonomous functioning, learning strategies, and grit (Kroner et al., 2017; Ryan et al., 1991; Whitehead, 1984). Autonomous functioning involves learners assuming the initiative and responsibility for their learning and is a basic component of motivation as it provides learners with a sense of freedom, self-reliance, and self-regulatory behaviors (Smith & Darvis, 2017;

Yeargar et al., 2017). Learning strategies are a set of skills that assist in encoding new information and determining the level of internal processing (Hao & Othman, 2021; Shaala et al., 2018). Finally, grit is an individual's ability to persist, persevere, and maintain self-control and conscientiousness regardless of distractions or deterrents that may arise (Duckworth & Quinn, 2009; Park et al., 2020; Tang et al., 2019). The researcher's goal is to ascertain a potential predictive relationship between a student's level of self-directed learning based on literature-defined noncognitive variables (*students' self-regulation, motivation, autonomous functioning, learning strategies*, and *grit*).

Research Question

The research question for this study is:

RQ1: How accurately can self-directed academic performance as measured by end-of-term Yammer grades be predicted from a linear combination of noncognitive variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit*) for dental students?

Hypothesis

The null hypothesis for this study is:

$H_0$1: There will be no statistically significant predictive relationship between the criterion variable (students' self-directed learning; end-of-term Yammer grade) and the predictor variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies,* and *grit*) for dental students.

Participants and Setting

This section describes the study's setting, population, sampling procedures, sample size, and demographics. This study will occur at a four-year dental school in North

Carolina. Population includes the student enrollment total and demographics for this research site. Finally, the study's participants selection method is discussed, and a detailed treatment of participants based on academic classification, gender, and race is examined.

Setting

This research was conducted at a dental school located in a middle-class municipality in eastern North Carolina. The four-year program is conducted on campus and in satellite clinics around the state. Academic years are disaggregated into three-month-long semesters and continue year-round. The first two years are heavily didactic with lecture and basic dental hand skills being the primary forms of instruction and learning. During the third- and fourth-year guided clinic advanced topics are added to the students' course loads. In this setting, students are paired with a lead faculty member, and they collaborate to provide care for patients both as primary care and assistant. This permits the student to practice what one has learned in his or her first two years with guided instruction. The final year of dental school is dedicated to clinic rotations, whereby students spend eight weeks at a time at a satellite clinic located within the state of North Carolina. In this setting, students are the primary caregivers, and faculty are available for assistance and consultation.

Population

The school site comprises 208 full-time students and 56 residents. As of the Fall 2021 term, the school's population consists of students predominantly between the ages of 20 and 25 (83%), while 10% are between the ages of 26 and 30, with less than 7% being 31 years of age and above. Forty-six percent of the population identify as white, 42% African American, 4% Hispanic, 3% Asian, and the remaining 5% identify as Other. Of the 208 full-time students selected as participants in this study, the sample consisted of 41 male and 47 female students.

Participants

Due to the scaffolded model of curriculum at this school site, the participants for this study were recruited via convenience sampling during the spring term of the 2021-2022 academic year from full-time enrolled students. Residents, or post Doctor of Dental Surgery students, were not chosen to participate in this study as they do not progress through the same curriculum model as students. The sample consisted of 88 students, of which 9 male and 19 female students represent the first-year cohort of students, 20 male, and 18 female students the second-year cohort, 12 male and 10 female students the third-year cohort. At the time of the study, there were no fourth-year students having just graduated. For correlational research, a sample size of 66, when assuming a medium effect size, statistical power of .7, $\alpha = .05$ (Gall et al., 2007). For this study, the number of participants exceeded this required minimum.

Instrumentation

Four surveys were distributed in a single software package facilitated by the Qualtrics software for this study. These include the Learning Self-Regulation Questionnaire, Index of Autonomous Functioning, Motivated Strategies for Learning Questionnaire, and Grit Questionnaire.

Learning Self-Regulation Questionnaire

The Learning Self-Regulation Questionnaire (SRQ-L) measures the reasons why students, such as those in dental school course, learn in specific types of academic settings (Center for Self-Determination Theory, 2020). Designed in conjunction with the Academic Self-Regulation Questionnaire (SRQ-A), which was written for K-12 students, this questionnaire was developed for college and professional students. As such, two subscales were identified (autonomy and controlled) and the SRQ-A established validity and reliability. Autonomous

regulation is characterized by identified regulation (self-determination) and intrinsic motivation. Controlled regulation includes extrinsic motivations such external or introjected regulation.

Using external and introjected regulation (controlled) and identified regulation and intrinsic motivation (autonomy) as prototype reasons, elementary schools in three districts were administered the SRQ-A survey. Results were then tested for generalizability and validity. Results demonstrated that "reasons categorized as identified were most strongly endorsed (M = 3.23), followed by external (M = 2.85), introjected (M = 2.71), and intrinsic (M = 2.32) reasons" (Ryan & Connell, 1989). Further tests found an internal consistency estimate for each reason category to range from α = .62 to .82. These Cronbach alpha scores indicate questionable to good internal consistency which will be included as a limitation of this study (Cortina, 1993). Despite this lower Cronbach alpha score, this instrument continues to be among the standard instruments when measuring self-regulated learning tendencies. This is due to the concept that self-regulated learning is not considered a stable trait to measure (Center for Self-Determination Theory, 2020). As such, this questionnaire was written so as to provide flexibility that matches students' unique responses, but can also be categorized as autonomous and controlled regulated learning (Center for Self-Determination Theory, 2020). Ryan and Connell (1989) then created an adjacency index and computed the amount of variance associated with the reason categories. Using squared correlations to meet the assumptions of a correlational test, "analysis resulted in a congruency coefficient of .79 (p < .01), demonstrating that more than 60% of the variance in squared correlations is accounted for by the adjacency index" (Ryan & Connell, 1989). This instrument has been administered as a component in numerous studies (e.g., Carey et al., 2004; Chen & Lin, 2018; Pichardo et al., 2014).

The proposed survey follows the Black and Deci (2000) scale, which was modified to fit the health sciences. This survey included 12 items representing the three categories, each with four items. The three categories include: “I will participate actively in dental school because…”; “I am likely to follow the faculty’s suggestion for studying because…”; “The reason that I work to expand my knowledge of dental medicine is because…” Four preselected responses for each category represent the regulatory styles (identified regulation, intrinsic motivation, external regulation, and introjected regulation).

Responses follow a seven-point Likert scale, ranging from *very true to not at all* true. The low score for this questionnaire was 12 points. Students that scored at or near 12 points demonstrated low self-regulation abilities. The high score for this questionnaire was 84. The higher the score, the greater the self-regulation abilities. In past studies, the alpha reliabilities for these scales have been 0.75 for controlled regulation and 0.80 for autonomous regulation. It is suggested that students that have a better ability to self-regulate can control their emotions and behavior better and are more able to manage the varying activities of the day (Chen & Lin, 2018). The Learning Self-Regulation questionnaire requires an average of seven minutes to complete.

Index of Autonomous Functioning

Weinstein et al. (2012) developed the Index of Autonomous Functions (IAF) to measure three constructs: authorship/self-congruence, interest-taking, and low susceptibility to control. Authorship/Self-Congruence represents the autonomous; the individual experiences themselves as the author of behavior and fully sanctions his or her actions. Interest-Taking is the spontaneous tendency of individuals to reflect on inner- and outer-events openly. It facilitates awareness and ongoing insight into oneself and one’s experiences, which is essential for the high

level of self-governing involved in autonomy (Loevinger, 1976; Ryan & Deci, 2006; White, 1963). Low Susceptibility to Control is opposite from Authorship and Interest-Taking in that it encompasses feelings of pressure and the loss of sense of control. This suggests that the absence of external and internal pressure is a motivator for behaving (Deci et al., 1994).

Several studies have administered the IAF (Benka, n.d.; Natia & Nino, 2020; Oguntayo, 2021). According to Weinstein et al. (2012), results from this instrument "showed consistency within and across subscales and appropriate placement within a nomological network of constructs." Seven studies were conducted to establish reliability and validity (Weintstein et al., 2012). The first four studies were designed to create a reliable and valid scale. The final three examined individual's daily experience and explored the interpersonal effects of dispositional autonomy in a lab-based design. The results are included in Appendix H.

This survey included 15 items representing the three constructs. Each subscale consists of five items representing each construct, and the individual items are rated on a 5-point Likert scale. Instructions for this section are: "For each of the following statements, please indicate how true it is for you, using the following scale: *Very true = 5, Sort of true = 4, Neutral = 3, Not very true = 2, Not at all true = 1.*" The low score for this questionnaire is 15 while there is a possible maximum score of 75. A higher score represents a higher level of inter-individual differences in autonomous functioning (Weinstein et al., 2012). The survey requires five minutes to complete.

Motivated Strategies for Learning Questionnaire

The Motivated Strategies for Learning Questionnaire (MSLQ) is based on a general cognitive view of motivation and learning strategies. The purpose of this instrument is to measure the academic motivation and learning strategies implemented by college students (Pintrich et al., 1993). Multiple subscales encompass motivation and learning strategies, all of

which exert predictive power over final course grades (Pintrich, 1990). This instrument has been administered as a component in several studies (e.g., Cho & Summers, 2012; Pintrich et al., 1993; Smith & Chen, 2017) and has demonstrated the ability to assess student motivation and application of learning strategies in higher education classrooms. The Motivation section consists of six scales: Control beliefs about learning, extrinsic goal orientation, intrinsic goal orientation, self-efficacy for learning and performance, test anxiety, and task value. The learning strategies section consists of nine scales: critical thinking, effort regulation, elaboration, help-seeking, metacognitive self-regulation, organization, peer learning, rehearsal, time, and study environment. The shortened version of the instrument comprises 44 items. According to Pintrich et al. (1993), this instrument exhibits good reliability in terms of internal consistency and validity (see Appendix I: Reliability Scores for MSLQ and Appendix J: Validity Scores for MSLQ).

Respondents may respond to all items via a five-point Likert scale. Instructions for this section are: "For each of the following statements, please indicate how true it is for you, using the following scale: *Very true = 5, Sort of true = 4, Neutral = 3, Not very true = 2, Not at all true = 1.*" The low score for this questionnaire was 44 and the high score of 220. High scores on this questionnaire reflect a student's heightened ability to apply learning strategies to various scenarios and increase academic performance (Smith & Chen, 2017). The average completion time for the MSLQ was 15 minutes.

Grit-S Questionnaire

Duckworth et al. (2007) defined grit as "trait-level perseverance and passion for long-term goals." It entails the capacity to sustain both effort and interest in projects that could require more extended periods to complete despite the absence of positive feedback. In a study involving adults, findings indicated that adults with higher grit levels progressed farther in their education

and made fewer career changes than adults with lower grit levels (Duckworth, & Quinn, 2009). According to Duckworth and Quinn (2009), "using age as a covariate, both Grit-S (α =0.21, odds ratio [OR] = 1.23, p<.001) and age (α=0.22, OR=1.25, p<.001) were significant predictors." As this study focuses on a unique population, where students seek a specialized education to aid them in their careers, this instrument is appropriate.

The purpose of the Grit-S scale is to measure "the extent to which individuals are able to maintain focus and interest, and persevere in obtaining long-term goals" (Rand, 2018). The Grit-S scale consists of three subscales: Consistency of Interests, Perseverance of Effort, Motivation/Persistence and Study Habits. According to Duckworth et al. (2007), these factors "demonstrated high internal consistency (α = .85) for the overall scale and for each factor (Consistency of Interests, α = .84; Perseverance of Effort, α = .78)." As developed by Duckworth and Quinn (2009), the Grit-S scale was first validated by the authors in their initial study (see Table 4). In this study, the scale was found to be consistent and maintained the same reliability as the longer version of the Grit instrument.

Table 4

Development and Validation of the Short Grit Scale (Grit–S)

Removed to comply with copyright, refer to Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (GRIT–S). *Journal of Personality Assessment*, *91*(2), 166-174.

This survey comprises 8 items offering respondents a 5-point Likert scale for answering. Responses range from 1 (*not at all gritty*) to a possibility of 5 (*extremely gritty*). The low score for this questionnaire was 30 points, while the high score was 150 points. Individuals that

demonstrate significant grit have displayed maintenance in their determination and motivation over long periods despite experiences with failure (Duckworth et al., 2007). The average completion time was 12 minutes.

Academic Performance

Data gathered from the surveys was then compared to students' academic performance. Similar to Sedlacek and Adams-Gaston (1992) and Veas et al. (2015), this study measures academic performance by collecting end-of-term (EOT) grades. For the research site, each assignment comprises a certain number of points. One relative value point (RVU) is assigned to fifteen minutes of curriculum participation during the curriculum mapping process. Fractional points were assigned to posts based on the estimated time necessary to write and post, with 0.1 points as the minimal points possible for any post (T. Watkins, personal communication, August 23, 2021). These points are entered into the eXtensible Competencies Platform (XComP), a web-based, school-designed platform developed to holistically track each student's performance in real-time (Watkins, n.d.). It is organized by thirty key competencies that students must master throughout their time in dental school (T. Watkins, personal communication, August 23, 2021). These competencies help evaluate if the content of student posts is relevant to content taught in the courses. EOT YAMMER grades are determined by the total points accumulated for the term and then converted into a 4-point Cumulative Point Average (CPA) continuous scale that ranges from 0.1 to 4.0. Students that score at or near 0.1 are the lowest academic performers, while students that score closer to 4.0 are considered top of their class.

Procedures

Before conducting the study, permission was obtained from the research site (see Appendix A). Next, the researcher submitted the research proposal to the Liberty University

Institutional Review Board (IRB) and the research site for approval (see Appendices B and C). The Learning Self-Regulation Questionnaire, Index of Autonomous Functioning, Motivated Strategies for Learning Questionnaire, and Grit-S questionnaire were digitized, in that order, and distributed by the researcher in a single software package facilitated by the Qualtrics software. At the beginning of each instrument's section, instructions were provided explaining the purpose and answering protocols needed for that section. There were four to six questions per page totaling twenty-five digital pages. Once students complete a page, they click on the "next" arrow button to navigate through the survey. Once students complete the survey, scores are automatically submitted, and a message of appreciation is displayed. Students can then exit their web browser to close out the survey. The research site provided any requested data to the researcher through a password-protected email account. Both survey data and archival data were stored on a password-protected computer restricted to researcher-only access.

Course grades are considered archival data and can be collected via end-of-term grades stored within school databases (McMillan, 2004). Demographic information, including students' sex, race, age, and academic grade level was also collected. The research site created and distributed a Microsoft Excel spreadsheet containing the requested demographic and grade data. This information was arranged with individual columns and rows representing each student's data. The requested archival student data were selected from the fall 2021 semester. The requested information was compiled by the Associate Dean of Education and Informatics, deidentified, and sent to the researcher via encrypted email. Data in each row from the Microsoft Excel spreadsheets was entered into SPSS Version 27 data analysis system, where the appropriate data analysis tests were performed.

Student email addresses in the form of class group emails were provided to the researcher by the research site. Using these group emails, participants were recruited via a convenience sampling method. An email was written and sent by the researcher to all active students enrolled in the research site informing them of the purpose, procedures, and significance of the study as well as the individual's responsibilities as a study participant should he or she wish to participate (see Appendix D). The email concluded with the study link and directed the individual to click on the link should he or she wish to participate in the study, while those who did not wish to participate were thanked for their time and instructed to close the email. Once willing participants clicked on the link, the study Qualtrics website was opened, and participants viewed the informed consent form. Participants were directed to read the consent form (see Appendix E). If the participant clicked *No* (do not consent), he or she automatically navigated to a new screen thanking him or her for his or her time and interest in the study. If the individual consented to participate in the study, he or she clicked *Yes*, he or she was automatically navigated to the next screen where he or she input his or her name and class designation to begin the survey. Should a participant wish to withdraw from the study, they exit the survey and close their internet browser. Responses from these participants will not be recorded or included in the study. The information on this site is only accessible by a password-protected login known only to the researcher. Students were provided two weeks to complete this survey. Reminder emails were sent at the end of the first week and halfway through the second week (see Appendix F).

Data Analysis

For this study, the data was analyzed via multiple regression. This method of data analysis is appropriate for this study for many reasons. First, according to Gall et al. (2007), the objective of multiple regression analysis is to implement the research participants' scores on

some or all the predictor variables to predict their scores on each criterion variable. For this reason, it is commonly applied in educational research as it permits researchers to determine the correlation between a criterion variable and numerous predictor variables (Gall et al., 2007). One advantage of including multiple predictors in the regression is to explore the extent to which two or more predictor variables interact (Pivitera, 2012). Further, it estimates both the magnitude and the statistical significance of relationships between variables (Gall et al., 2007). The purpose of multiple regression analysis in this study is to determine whether the predictor variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit)* can be combined to form the best prediction model of the criterion variable (self-directed learning). For this reason, a multiple regression was appropriate as it aids researchers in measuring the scope and significance of relationships and interactions among numerous predictors and criterion variables (Gall et al., 2007).

Studies similar to the present implemented multiple regression analysis as the data analysis. Lee et al. (2018) examined the relationship between pre-admission data and performance on the entrance exams for dental students. Multiple regression results indicated no significant predictive capability (R^2=0.15) of entrance exams on student GPA. Rowland and Reiken (2018) sought to determine if pre-admission variables, such as undergraduate GPA and dental entrance exams affected dental students' first-year GPA. A multiple regression analysis revealed a "significant association was found between pre-admission variables and first-year GPA, but the association was weak (adjusted R^2=0.238)." Sumuer (2018) focused on noncognitive variables and students' self-directed learning with technology. Their results revealed a "medium, positive significant correlation between SDL with technology and SDL readiness (r = .37, p < .001). In addition, there was a small, positive significant correlation of

SDL with technology with the implementation of Web 2.0 tools for learning (R^2=.14, p < .01), online communication self-efficacy (R^2 = .19, p < .01), and computer self-efficacy (R^2 = .19, p < .01)" (Sumuer, 2018). This suggests that a multiple regression analysis is appropriate for this study.

Assumption Tests

Using SPSS Version 27, three assumptions must be met before conducting multiple regression analysis. These assumptions include the absence of bivariate outliers, multivariate normal distribution, and non-multicollinearity (Warner, 2013). Outliers are data points whose scores are vastly different from other scores within the sample (Gall et al., 2007). These points can negatively affect the regression equation and reduce the results' predictive accuracy and statistical significance. This was completed by examining a scatterplot, determining a visual shape of an ellipse, and identifying points that fall outside this shape (Gall et al., 2007)

A linear relationship between variables is necessary for a multiple regression to succeed. In testing for multivariate normal distribution, the researcher examined a scatterplot to assess linearity (Green & Salkind, 2017; Warner, 2013). Multicollinearity occurs when two or more variables are highly inter-correlated. This assumption was assessed to prevent issues with understanding which predictor variable contributes to the variance explained in the dependent variable. To test for non-multicollinearity, each predictor variable (academic self-regulation, learning self-regulation, motivation, autonomous functioning, learning strategies, and grit) and the criterion variable (academic performance) were plotted to examine for a linear relationship (Warner, 2013). Variance inflation factor (VIF) values were then assessed as any VIF greater than 10 indicates problematic collinearity (Stine, 1995). Values above ten would indicate the

potential difficulty in assessing the predictive capabilities of the predictor variables (Warner, 2013).

A multiple regression was conducted for SDL performance. In keeping with Warner (2013) and Gall et al. (2007), the sample size of 88 is greater than the 66 when assuming a medium effect size with .7 statistical power, $\alpha = .05$. When reporting results, the researcher analyzed the *F* ratio to determine rejection of or failure to reject the null. Cohen's f^2 will be calculated to determine the effect size for this study (Cohen, 2013). An $f^2 \geq 0.02$ is considered a small effect size, while $f^2 \geq 0.15$ is considered medium, and an $f^2 \geq 0.35$ is considered a large effect size (Cohen, 2013). After conducting statistical tests and analyzing data, the researcher attempted to reject the null hypothesis at the 95% confidence level.

CHAPTER FOUR: FINDINGS

Overview

This study aimed to investigate the predictive relationship between students' noncognitive variables and their academic performance. This chapter restates the purpose, research question, and hypothesis. A correlational analysis investigated if fluctuations in the predictor variable, student's noncognitive variables, and criterion variables, student self-directed learning are related. The descriptive statistics and a detailed data analysis for this study are discussed. The chapter concludes with a summary of the significant findings.

Research Question

The research question for this study is:

RQ1: How accurately can self-directed academic performance as measured by end-of-term Yammer grades be predicted from a linear combination of noncognitive variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit*) for dental students?

Null Hypothesis

The null hypothesis for this study is:

$H_0$1: There will be no statistically significant predictive relationship between the criterion variable (students' self-directed learning as measured by end-of-term Yammer grade) and the predictor variables (*self-regulation, intrinsic motivation, autonomous functioning, learning strategies,* and *grit*) for dental students.

Descriptive Statistics

The participants for this study were recruited via convenience sampling from a dental school located in North Carolina during the Spring 2022 academic semester. While the survey

instrument was administered via email, the Fall semester, 2021 self-directed academic performance as measured by end-of-term (EOT) Yammer grades were provided to the researcher from the research site. Data from the survey and grades were downloaded as an SPSS dataset.

Descriptive statistics were obtained pertaining to each of the survey subscales for the independent variables, *self-regulation, autonomous functioning, motivation, learning strategies,* and *grit,* and the dependent variable, self-directed academic performance as measured by Yammer grades (see Table 5).

Table 5

Descriptive Statistics

	M	*SD*	*N*
Grades	2.63	2.03	88
SelfRef	1.42	0.96	88
AutoFunc	4.95	0.60	88
Motivation	4.40	0.54	88
LearnStrat	6.16	1.01	88
Grit	5.93	0.39	88

There were N=88 that participated in the study. Of this sample, 51% reported as male, and 49% were female participants. For correlational research, a sample size of 66 is necessary when assuming a medium effect size with a statistical power of .7, $\alpha = .05$ (Gall et al., 2007). For this study, the number of participants exceeded this required minimum, resulting in Cohen's $f^2 = 0.48$, indicating a large effect size.

Assumptions Tests

A multiple regression was conducted to assess if self-directed academic performance can be predicted by a linear combination of noncognitive variables. Prior to conducting multiple regression, the parametric assumptions were tested. According to Field (2018), these

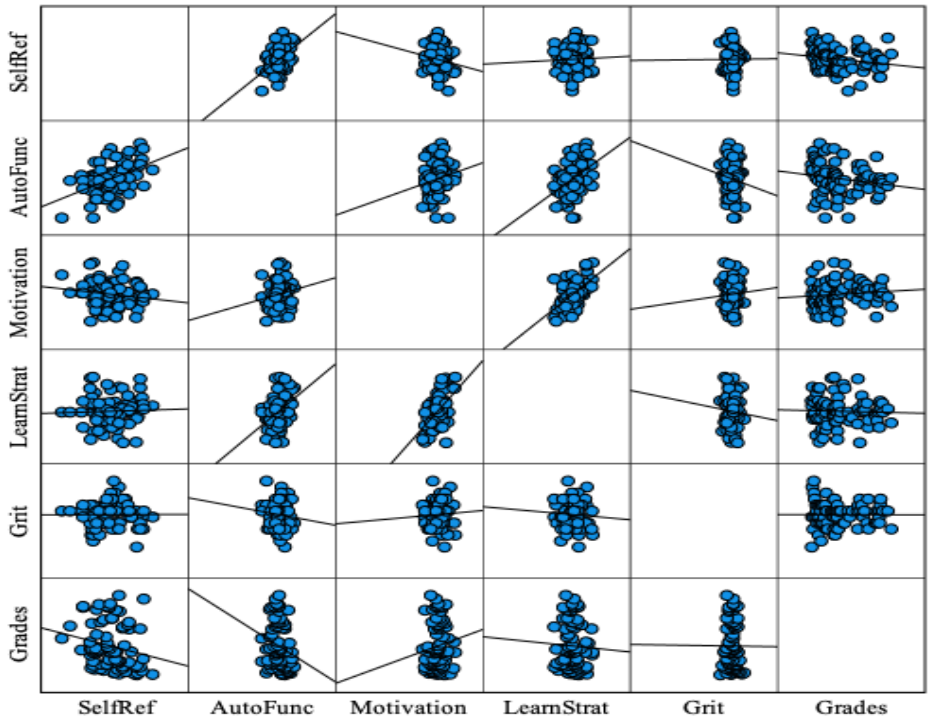
assumptions include assumption of bivariate outliers, assumption of multivariate normal distribution, and assumption of non-multicollinearity. Using SPSS, these assumptions resulted in two violations.

Assumptions of Linearity, Bivariate Outliers, and Multivariate Normal Distribution

A matrix scatter plot with the superimposed line of best fit was constructed to test for linearity, bivariate outliers, and normal distribution (see Figure 1). The first assumption test assessed the linear relationship between the independent and dependent variables (Field, 2018). Scatterplots with the superimposed line of best fit demonstrated that the relationship between the IVs and the DV is nonexistent, and this assumption may be violated. The second assumption test applied the scatterplot matrix to detect if bivariate outliers between each of the predictor variables and between the predictor variables and the criterion variable were present. No extreme bivariate outliers were present. A multiple regression also requires that the assumption of a bivariate normal distribution be met. A visual inspection of the scatterplots was conducted to assess the assumption of multivariate normal distribution. Overall, a cigar-shaped pattern was observed in the higher density areas of each plot, however, some deviation from the ideal bivariate normal pattern was present. Research continued with the analysis considering the two violations.

Figure 1

Matrix Scatterplot.



Assumption of Multicollinearity

Multicollinearity diagnostics analysis was conducted via the variance inflation factor (VIF, see Table 6). Collinearity statistics indicate that there is very little correlation between the predictor variables. Analysis of collinearity statistics shows this assumption has been met as VIF scores were well below 10 and tolerance scores above 0.2.

Table 6

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
		B	*SE*	*β*	*t*	*p*	VIF
1	(Constant)	6.128	4.108		1.492	.140	
	SelfRef	-.091	.270	-.043	-.337	.737	1.413
	AutoFunc	-.650	.451	-.191	-1.441	.153	1.530
	Motivation	.484	.497	.129	.974	.333	1.524
	LearnStrat	-.214	.258	-.106	-.828	.410	1.436
	Grit	-.162	.564	-.031	-.288	.774	1.022

Results

Hypothesis

H₀1: *There will be no statistically significant predictive relationship between the criterion variable (students' self-directed learning as measured by end-of-term Yammer grade) and the predictor variables (self-regulation, intrinsic motivation, autonomous functioning, learning strategies, and grit) for dental students.*

A multiple linear regression was conducted to investigate the potential for noncognitive variables including self-regulation, autonomous functioning, motivation, learning strategies, and grit to significantly predict participants' self-directed learning as measured by EOT Yammer grades. The results of the regression indicated that the model explained R^2 =.003, or 0.3% of the variance (see Table 7). The Analysis of Variance (ANOVA) was examined to further determine if the model is a significant predictor of the outcome variable (see Table 8). The overall model was not statistically significant, $F(5,82) = 1.05$, p =.394, suggesting that this regression model does not significantly predict SDL.

Table 7

Model Summary[b]

Model	*R*	R^2	*Adjusted* R^2	Std. Error of the Estimate	Durbin-Watson
1	.245[a]	.060	.003	2.02639	2.042

a. Predictors: (Constant), Grit, Motivation, SelfReg, LearnStrat, AutoFunc
b. Dependent Variable: Grades

Table 8

ANOVA[a]

Model		*SS*	*df*	*MS*	*F*	*p*
1	Regression	21.570	5	4.314	1.051	.394[b]
	Residual	336.715	82	4.106		
	Total	358.285	87			

a. Dependent Variable: Grades
b. Predictors: (Constant), Grit, Motivation, SelfReg, LearnStrat, AutoFunc

Since this model failed to provide a predictive relationship, a Pearson's product-moment correlation coefficient was conducted to determine the degree to which a relationship exists between the variables (McMillan, 2004). Of the five relationships that emerged, two are considered weak positive relationships: self-regulation and motivation (r = .27), and motivation and autonomous functioning (r = .28). The remaining three relationships produced moderate positive relationships: self-regulation and autonomous functioning (r = .37), motivation and learning strategies (r = .47), and autonomous functioning and learning strategies (r = .34). This information is shown in Table 9.

The null hypothesis failed to be rejected as no significant predictive relationship existed between the criterion variable (self-directed learning), however, there existed a correlation

between variables (self-regulation, autonomous functioning, motivation, learning strategies, and grit).

Table 9

Correlations

		Grades	SelfReg	AutoFunc	Motivation	LearnStrat	Grit
Grades	Pearson Correlation						
	Sig. (2-tailed)						
SelfRef	Pearson Correlation	-.133					
	Sig. (2-tailed)	.216					
AutoFunc	Pearson Correlation	-.203	.368**				
	Sig. (2-tailed)	.058	<.001				
Motivation	Pearson Correlation	.033	-.266*	.278**			
	Sig. (2-tailed)	.757	.012	.009			
LearnStrat	Pearson Correlation	-.103	-.119	.335**	.496**		
	Sig. (2-tailed)	.339	.268	.001	<.001		.543
Grit	Pearson Correlation	-.014	-.044	-.098	.028	.066	
	Sig. (2-tailed)	.897	.684	.365	.793	.543	

Note. **. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Summary

The purpose of this quantitative, predictive correlational study was to determine the potential predictive relationship between noncognitive, potentially confounding variables that may affect self-directed learning academic performance. Results of multiple regression did not demonstrate a significant predictive model; however, moderately strong relationships did exist. A Pearson's product-moment correlational analysis was conducted resulting in five statistically significant relationships. Chapter Five follows this data analysis with a discussion of how the

results of this study are interpreted in the context of the theoretical framework as well as exploring the limitations and results of this study.

CHAPTER FIVE: CONCLUSIONS

Overview

The purpose of this quantitative, predictive correlational study was to determine the potential predictive relationship between noncognitive variables and self-directed learning academic performance. This chapter provides a detailed summary and a discussion of the findings. These findings are then discussed further within the greater context of relevant literature and the conceptual framework of the study. The limitations of the research are evaluated, and implications are discussed. This chapter concludes with recommendations for future related research.

Discussion

In recent years, there has been a movement to modernize dental curricula to connect foundational coursework and clinical experiences using self-directed learning strategies. Literature suggests that traditional cognitive measures, such as standardized test scores and GPA, are the strongest predictors of higher education academic achievement (Richardson et al., 2012; Schneider & Preckel, 2017). However, these predictors do not adequately predict student abilities in unique educational settings such as dental schools where coursework and clinical experiences are equal. Farrington et al. (2012) proposed a framework for noncognitive factors and academic performance that addresses these shortcomings. This study aimed to determine possible relationships between students' noncognitive variables including self-regulation, motivation, autonomous functioning, learning strategies, and grit, and their self-directed learning abilities, as demonstrated by their end-of-term case-based and problem-based learning grades. In conducting a multiple regression, this noncognitive variable model only explained 0.3% of the variance and failed to reject the null hypothesis. This discussion will address the variables

represented in the research question, *self-regulation, intrinsic motivation, autonomous functioning, learning strategies,* and *grit* individually.

Self-Regulation

Self-regulated learning (SRL) can be defined as the "cognitive, metacognitive, motivational, and affective processes that learners use to systematically focus their thoughts, feelings, and actions on the attainment of their learning goals" (Schunk, 2020). It is a style of learning that requires an individual to assume control of and enhance their schooling to meet their needs (Wehmeyer, 2005). Although the Center for Self-Determination Theory (2020) considers self-regulated learning an unstable trait to measure, they provide the Learning Self-Regulation Questionnaire (SRQ-L). This instrument measures why students, such as those in dental school, learn in those types of academic settings (Center for Self-Determination Theory, 2020). Data analysis results for this study found that self-regulation did not significantly contribute to the model ($p = .7$). Additionally, the unstandardized beta coefficient is negative ($B = -.09$) meaning that for every one-unit increase in self-regulation, SDL grades decreased.

Studies conducted in medical education settings have demonstrated that self-regulated learning in case-based and problem-based learning encounters helps students with self-efficacy, think critically, cope with challenges, and promote the reflection process (Evenson, 2000; Hmelo & Lin, 2000). While this study did not measure these variables explicitly, the research site assured the researcher that self-directed learning, and, subsequently, SDL grading via Yammer grades, are so performed considering these elements. As such, this study contradicts the literature on this point. Furthermore, the literature suggests that self-regulation positively relates to academic achievement and persistence in higher education (e.g., Panadero, 2017). Results from this study suggest the opposite at least with this population.

Like Duchatele & Donche's (2019) study, this study found that students accessed self-regulatory skills more in class during their instructor-led case seminar encounters (case-based learning). However, there existed no significant relationship with self-regulatory skills outside of class (problem-based learning). Studies suggest self-regulated learning is a developing process (Ma & Lu, 2019; Yeo & Chang, 2017). At this research site, the students are given a one-hour introduction to Yammer with reference materials; however, after the tutorial, they are left to self-directed learning with little support or guidance from the faculty. In conjunction with the current study, these studies suggest that learners first introduced to self-directed learning often need additional assistance and direction. Eventually, as supports are removed, students are more able to participate in self-regulated learning.

Autonomous Functioning

Ryan and Deci (2017) described autonomous functioning as “the need to self-regulate one’s experiences and actions, entailing a form of functioning associated with feeling volitional, congruent, and integrated.” Essentially, the learners rather than the teachers assume control of their education. This study applied the Index of Autonomous Functioning or IAF. This instrument measured students' functioning regarding authorship/self-congruence, interest-taking, and low susceptibility to control. For this population, this study found autonomous functioning did not significantly contribute to the model (p = .2), and B = -.65 demonstrates a negative effect on students' SDL grades.

Findings from this study largely contradict the current literature on autonomous functioning. Yeagear et al. (2017) found that students who practiced autonomy demonstrated a deeper understanding of the course concepts and improved academic achievement. Furthermore, studies suggest a learning environment where students exert control over their behaviors and

choices increases interest and perceived value of the task (Deci & Ryan, 2000; Heindle, 2018; Jang et al., 2010; Oudeyer et al., 2016; Vansteenkiste et al., 2006).

Studies have found that autonomous functioning improves students' overall motivation (Heindle, 2018; Oudeyer et al., 2016). The current study found this to be accurate within this population. A Pearson's product-moment correlation revealed a low, positive correlation between autonomous functioning and motivation (r = .278). Aligned to current literature, this study suggests that teachers should support learner autonomy by guiding their learning process (Duchatelet & Donche, 2019; Reeve et al., 2004).

Motivation

Research suggests that students who are more intrinsically motivated are more likely to engage in SDL (Deci & Ryan, 1985; Schmidt, 1983). According to Whitehead (1984), *intrinsic motivation* utilizes a student's internal reward system to explain their curiosity, ability to overcome new tasks, and collaboration skills (Whitehead, 1984). This study administered the Motivated Strategies for Learning Questionnaire (MSLQ) to measure student motivation regarding their control beliefs about learning, extrinsic goal orientation, intrinsic goal orientation, self-efficacy for learning and performance, test anxiety, and task value. These contribute to motivation's predictive power over final course grades (Pintrich, 1990). This study found motivation did not significantly contribute to the model (p = .3). However, a positive unstandardized beta coefficient does suggest that as motivation increases, so do their SDL grades (B = .5).

Motivation is a core concept in noncognitive variable literature. According to Di Serio et al. (2013), motivation explains why and how learners achieve their academic goals. While motivation did not statistically contribute to this model, it was the only variable tested that

positively related to grades (r = .03). Literature also suggests that motivation is related to other noncognitive variables. Similar to Kahn et al.'s (2019) findings, this study found that motivation produces a moderate, positive relationship with implementing learning strategies (r = .47). Di Serio et al. (2013) also discovered a connection between motivation and self-regulated learning. Similarly, this study resulted in a low, negative relationship with self-regulated learning (r = -.27).

Like Duchatelet and Donche's (2019) study, data suggest that students' motivation formulates their efforts in unique learning environments. However, as motivation did not statistically contribute to the overall model, this suggests a lack of motivation could be an obstacle to learner success (Wei et al., 2015). Kirschner et al. (2006) provided that one possible explanation is that inquiry-based teaching with minimal guidance does not work and could be considered the most ineffective learning technique (Bruner, 1973).

Learning Strategies

Farrington et al. (2012) defined learning strategies as a set of skills that support student learning, and students who apply them enjoy better control over their information processing (Winne, 2001). The current study administered the learning strategies section of the MSLQ to measure student ability in critical thinking, effort regulation, elaboration, help-seeking, metacognitive self-regulation, organization, peer learning, rehearsal, time, and study environment. According to Pintrich (1990), all of these maintain predictive power over final course grades. This study indicated the use of learning strategies did not significantly contribute to the model (p = .4), and a negative unstandardized beta coefficient (B = -.2) also suggests that as their application of learning strategies increased, SDL grades decreased.

While there was no predictive power of learning strategies in this population, it did reinforce current literature results in that it demonstrated positive relationships with other noncognitive variables. For example, Cho et al. (2021) posited that an increase in motivation also increased students' use of learning strategies. The current study found a moderate, positive relationship between motivation and learning skills (r = .47). Furthermore, this study also shows a moderate, positive relationship between learning strategies and autonomous functioning (r =.34) suggesting individuals who engage in academic work for personal reasons also implement behavioral, cognitive, and affective skills to accomplish them (Deci & Ryan 2002; Vallerand & Ratelle 2002).

Grit

Grit is defined as passion and perseverance in pursuing long-term goals (Duckworth, 2016). The Grit-S scale was administered to measure students' consistency of interests, perseverance of effort, motivation/persistence, and study habits. While grit has repeatedly predicted academic performance throughout the literature (Lucas et al., 2015; Rogalski, 2018), other studies have indicated this is not the case (Akin & Arslan, 2014; Buller, 2012; Duckworth et al., 2007). Within this population, grit produced the least predictive power over SDL grades (p = .78), and B = -.162 suggests that for every one-unit increase in grit, SDL grades decreased. This contradicts the limited research pertaining to grit and dental education. Montas et al. (2021) surveyed all students in the United States attending an American Dental Association (ADA) accredited dental school. Data analysis demonstrated a relationship between grit and higher levels of academic achievement. However, Al-Zain & Abdulsalam (2022) discovered mixed results between grit and dental education achievement.

Within medical education, research primarily focused on levels of grittiness and not the predictive power of grit. Based on Duckworth et al.'s (2007) findings, it is hypothesized that grit

could and should predict dental academic achievement. However, in their study with the West Point cadet population, Duckworth et al. (2007) reported that the Grit-S scale might better predict the completion of only significant accomplishments which could specifically explain the lack of predictive power with SDL. Furthermore, a study assessing grit in medical education demonstrated that it did not predict students' basic science knowledge (Miller-Matero et al., 2018). At the research site used for the current study, self-directed learning primarily deals with the students' ability to learn and utilize their basic science knowledge. This could further explain why grit did not produce a predictive relationship with SDL end-of-term grades.

Grit in and of itself conflicts with key aspects of andragogy and self-directed learning. Namely, both constructs rely on the individual to self-assess his or her learning needs and establish his or her own learning goals. On the other hand, grit assesses the individual's willingness to do this but measures his or her success based on cognitive means established by the educational institution (Pemberton & McCadden, 2019). Another critical aspect of andragogy and SDL is that intrinsically motivated students are more likely to succeed. Grit relies on external motivating factors such as course grades and completion. Indeed, this study revealed no relationship between grades and grit (r = -.01), or even motivation and grit (r = .03). Literature suggests that these pitfalls can be addressed within the proper educational setting. Ali (2019) indicated that CBL and PBL comprise environments where grit can flourish. However, it needs to be guided and structured for students to succeed (Bailey et al., 2020; Thorsen et al., 2021).

Implications

This study adds to a very limited body of knowledge related to noncognitive variables and self-directed learning within dental education. The current study concluded that the social context in which self-directed learning occurred did affect the students' ability to apply

noncognitive variables, as suggested by the social cognitive learning theory. However, in contrast to andragogy's ideal that adult learners are more self-directed, this study suggests that students are either unwilling to or cannot participate in explicitly self-directed learning. This, too, could further be explained by the social cognitive learning theory. Students who have not experienced this learning style may feel uncomfortable discussing course content in this format and may be more inclined not to participate. Furthermore, students may not be willing to engage in conversations where they contradict or criticize their peers and potentially damage relationships with those they will spend considerable amount of time with for four years.

This study provides institution-specific data that could aid faculty in supporting self-directed learning. Special care should be extended to provide more opportunities for students to develop their self-directed learning under the guidance of faculty. Once mastery has been demonstrated, these supports can be removed and students can direct their learning. In concert with the social cognitive learning theory, institutions could investigate creating more peer mentoring groups to promote the acquisition of noncognitive variables with self-directed learning. This study also suggests that many aspects of noncognitive variables in dental education merit further investigation.

Limitations

Limitations of the study involve factors related to the survey data, the generalizability of the population studied, and potential factors specific to the self-directed academic performance variable. Within the survey data, reporting bias was a potential limitation. As the questions posed within the surveys were personal and required self-reflection, respondents may have chosen answers relating to more favorable or desirable personal traits. This may have been partially mitigated by the established safeguards designed to ensure the anonymity of respondents.

Another limitation could be survey fatigue. While the average response time was 20 minutes for the entire survey, there were roughly 36 pages of questions. However, the ability to complete the survey in several sessions at the discretion of the participants could have mitigated this issue. This study was also limited by the mode of sampling and data collection. The researcher accessed email to recruit participants and distribute the surveys which could have dramatically reduced the response rate. Furthermore, there was no guarantee for genuine responses from the participants. Finally, this study utilized a nonexperimental quantitative predictive correlational design. As such, the researcher cannot conclusively determine a causal relationship among the variables.

Another limitation of this study was the sample size. Although the number of participants exceeds the required statistical minimum, the study results from this small sample size may limit the generalization of the study findings and the transferability of results to other locations. Furthermore, since data were collected from only one dental education institution, the results from this study are relatively specific to this population. Generalizing these results would be complex, and further studies should be conducted in other settings to determine validity.

A lack of previous research applying self-directed academic performance is another study limitation. Little, if any, research has been completed regarding the internal reliability or predictive validity of self-directed academic performance, especially regarding Yammer. However, the validity of accessing end-of-term grades has suggested that this variable is relatively free of limitations such as external influences that could confound the results. This study assumes that self-directed academic performance grades adequately represent a student's unique ability and effort and are not skewed by unknown variables based on research completed using end-of-term grades.

Recommendations for Future Research

The methods and results from this study provide several opportunities for future research. These recommendations address weaknesses outlined in the Limitations section, and others are due to apparent gaps in the literature.

1. Similar research should be conducted with a larger sample size. This could be obtained by implementing multiple research sites.
2. Similar research could be conducted via a longitudinal study approach whereby the researcher gathers survey results and grading data over several semesters to determine if a statistically significant relationship emerges.
3. Similar research could be conducted that applies participant information to determine if there is a direct correlation between an individual's noncognitive variable and his or her self-directed learning abilities.
4. Similar research could be conducted that examines students' overall GPA in conjunction with their self-directed learning scores.
5. Exploring noncognitive variables as they relate to clinical performance could be beneficial.
6. A general study could explore the predictive factors of success within dental education.

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APPENDICES

Appendix A: Permission to Conduct Research Letter

School of Dental Medicine
Ledyard E. Ross Hall | 1851 MacGregor Downs Road | Mail Stop 701
East Carolina University | Greenville, NC 27834-4354
252-737-7000 office | 252-737-7049 fax | www.ecu.edu/dental

June 29, 2022

School of Education
Liberty University
1971 University Boulevard
Lynchburg, VA 24515

To Whom It May Concern,

I am writing this letter in my role as Interim Associate Dean for Research verifying that Ms. Jennifer Keim Wibbeler is approved/permitted to conduct her study titled, "A Correlational Study of Noncognitive Variables and Student Success in Dental Education" at East Carolina University (ECU) School of Dental Medicine. Ms. Keim Wibbeler is an employee of the School of Dental Medicine in the Office of Dental Education and Informatics. Ms. Keim Wibbeler is also a doctoral candidate (EdD) in Curriculum and Instruction at the Liberty University School of Education. She is working closely with her supervisor Dr. Robert Todd Watkins, Assistant Dean for Dental Education and Informatics on this project that aims to collect and analyze behavioral survey and academic performance data on dental students. The project (UMCIRB 22-000136) has been certified as exempt by the University and Medical Center Institutional Review Board at ECU.

Please feel free to contact me at [redacted] if you have any questions regarding Ms. Jennifer Keim Wibbeler and this institutional approval/permission to conduct the proposed research project.

Sincerely,

[redacted]

Appendix B: Liberty University IRB Approval

[External] IRB-FY21-22-645 - Initial: Initial - Exempt

do-not-reply@cayuse.com <do-not-reply@cayuse.com>
Thu 3/31/2022 1:50 PM
To: Wibbeler, Jenni <jwibbeler@liberty.edu>;Street, Nathan (Dept. of Music and Worship) <nstreet4@liberty.edu>

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

March 31, 2022

Jenni Wibbeler
Nathan Street

Re: IRB Exemption - IRB-FY21-22-645 A CORRELATIONAL STUDY OF NONCOGNITIVE VARIABLES AND STUDENT SUCCESS IN DENTAL EDUCATION

Dear Jenni Wibbeler, Nathan Street,

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:104(d):

Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document(s) should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible

modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,
G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

Appendix C: Research site IRB Approval

Tuesday, May 3, 2022 at 17:27:17 Eastern Daylight Time

Subject: IRB: Study Correspondence Letter
Date: Tuesday, May 3, 2022 at 12:17:34 PM Eastern Daylight Time
From: umcirb@ecu.edu
To: Keim Wibbeler, Jennifer Lynn

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **rede.ecu.edu/umcirb/**

Notification of Exempt Certification

From: Social/Behavioral IRB
To: Jennifer Wibbeler
CC: Robert Watkins
Date: 5/3/2022
Re: UMCIRB 22-000136
Noncognitives in Dental Education

I am pleased to inform you that your research submission has been certified as exempt on 5/2/2022. This is eligible for Exempt Certification under category # 1 & 2a.

It is your responsibility to ensure that this research is conducted in the manner reported in your applicatic and/or protocol, as well as being consistent with the ethical principles of the Belmont Report and your pro

This research study does not require any additional interaction with the UMCIRB unless there are propose changes to this study. Any change, prior to implementing that change, must be submitted to the UMCIRB review and approval. The UMCIRB will determine if the change impacts the eligibility of the research for e status. If more substantive review is required, you will be notified within five business days.

Document	Description
IRB ECU proposal.docx(0.01)	Study Protocol or Grant Application
JWibbeler ECU_Survey Consent.doc(0.01)	Consent Forms
JWibbeler_Recruitment Email.docx(0.02)	Recruitment Documents/Scripts
JWibbeler_Reminder Email.docx(0.02)	Recruitment Documents/Scripts
Qualtrics NCV in Dental Edu.pdf(0.01)	Surveys and Questionnaires

For research studies where a waiver or alteration of HIPAA Authorization has been approved, the IRB stat
each of the waiver criteria in 45 CFR 164.512(i)(1)(i)(A) and (2)(i) through (v) have been met. Additional
elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorizatio
been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418

Study.PI Name:
Study.Co-Investigators:

Appendix D: Recruitment Email

Hello,

I am collecting data for my research study and would appreciate your participation. The purpose of the study is to explore the relationship between noncognitive variables and students' self-directed learning in dental education. Your participation would require you to complete an online survey, which should take approximately 30-45 minutes and allow me to review your Yammer grades from the Fall 2021 semester. During the survey, should you need to exit and return to it later, you can simply click out of the survey. Your responses are automatically recorded and will pick up where you left off when you click back into the survey.

While the data collection consists of questions that will ask about your grades and academic performance, your responses will not be shared with faculty or staff. Your grades will not be altered or affected by your participation. Participation is completely voluntary, your responses will be kept confidential, and you have the right to withdraw at any time.

I ask that you please fill out this survey by **MM/DD/2022.**

If you have any questions, feel free to contact me, the principal investigator, via e-mail. Your participation is greatly appreciated. Thank you in advance.

Please follow this link to the survey:

Or copy and paste the URL below into your internet browser:

Sincerely,

Appendix E: Informed Consent Form

INFORMED CONSENT FORM

A CORRELATIONAL STUDY OF NONCOGNITIVE VARIABLES AND STUDENT SUCCESS IN DENTAL EDUCATION

Jenni Wibbeler
Liberty University
School of Education

You are invited to participate in a research study that seeks to explore the potential relationship between students' noncognitive variables and self-directed learning academic performance in dental education. Please read this form and ask any questions that you may have, prior to agreeing to be in this study.

Jenni Wibbeler is a doctoral candidate at Liberty University's School of Education and is conducting this study.

Background information: The purpose of this study is to explore the potential relationship between students' noncognitive variables and self-directed learning academic performance.

Procedures: If you choose to participate in this study, I will ask you to do the following things:

1. Participate in a 30-45-minute survey conducted through Qualtrics.
2. Permit me to gather data on your Yammer grades.

Risks: The risk involved with this study are minimal. There will be no impact on your grades or studies.

Benefits: Participants should not expect any direct benefit from participating in this study.

Compensation: Participants will not be compensated for participating in this study.

Confidentiality: The records of this study will be kept private. Research records will be stored securely, and the researcher will be the only one who has access to the records.

- Participants will be assigned a pseudonym.
- Data will be stored on a password protected computer and locked in a cabinet when not in use. Data may be used in future presentations. Data will be destroyed after three years.
- Survey scores will be recorded and stored through Qualtrics. After three years, these too will be destroyed.
- Only the researcher will have access to any data gathered in this study.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relationship with the school. If you decide to participate, you are free to not answer any questions or withdraw at any time.

How to withdraw from the study: If you choose to withdraw from this study, please contact the research using one of the contact methods listed below. Should you choose to withdraw, data collected from you will be immediately destroyed and will not be used in this study.

Contacts and Questions: The researcher conducting this study is Jenni Wibbeler. You may ask any questions you have now. If you have any questions later, please reach out to her at the contact information below.

Jenni Wibbeler
[redacted]

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you may reach out to the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515, or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information for your records.

Statement of consent:
I have read and understood the above information. I have asked questions and have received answers.

I consent to participate in this study.

No, I do not consent to participate in this study.

Appendix F: Reminder Email

Hello,

This is a reminder that I am collecting data for my research study and would appreciate your participation. The purpose of the study is to explore the relationship between noncognitive variables and students' self-directed learning in dental education. Your participation would require you to complete an online survey, which should take approximately 30-45 minutes and allow me to review your Yammer grades from the Fall 2021 semester. During the survey, should you need to exit and return to it later, you can simply click out of the survey. Your responses are automatically recorded and will pick up where you left off when you click back into the survey.

While the data collection consists of questions that will ask about your grades and academic performance, your responses will not be shared with faculty or staff. Your grades will not be altered or affected by your participation. Participation is completely voluntary, your responses will be kept confidential, and you have the right to withdraw at any time.

I ask that you please fill out this survey by **MM/DD/2022.**

If you have any questions, feel free to contact me, the principal investigator, via e-mail. Your participation is greatly appreciated. Thank you in advance.

Please follow this link to the survey:

Or copy and paste the URL below into your internet browser:

Sincerely,

Appendix G: Bivariate correlations between predictors and course performance

Table 10

Bivariate Correlations Between Predictors and Course Performance: One Preclinical Course and Four Clinical Courses.

Removed to comply with copyright, refer to Price, M. D., & Park, S. E. (2018). Can noncognitive components of admissions data predict dental student performance and postdoctoral program placement? *Journal of Dental Education*, *82*(10), 1051-1058.

Appendix H: Descriptive and reliabilities for the IAF

Table 11

Descriptive and Reliabilities for the IAF and its Subscales

Removed to comply with copyright, refer to Weinstein, N., Przybylski, A. K., & Ryan, R. M. (2012). The index of autonomous functioning: Development of a scale of human autonomy. *Journal of Research in Personality*, *46*(4), 397-413.

Table 12

Reliability scores for the Motivated Strategies for Learning Questionnaire

	Cronbach's Alpha														
	Intr	Extr	Tskv	Cont	Slfef	Tanx	Reh	Elab	Org	Crit	Meg	Tsdy	Eff	Prlm	Hsk
Motivation Scales	.74	.90	.62	.68	.93	.80									
Learning Strategies							.69	.76	.64	.80	.79	.76	.69	.76	.52

Note. Intr: Intrinsic Goal Orientation, Extr: Extrinsic Goal Orientation, Tskv: Task Value, Cont: Control Beliefs about Learning, Slfef: Self-Efficacy for Learning & Performance, Tanx: Test Anxiety, Reh: Rehearsal, Elab: Elaboration, Org: Organization, Crit: Critical Thinking, Mcg: Metacognitive Self-Regulation, Tsdy: Time and Study Environment, Eff: Effort Regulation, Prlrn: Peer Learning, Hsk: Help Seeking

Appendix J: Validity Scores for MSLQ

Table 13

Validity scores for the Motivated Strategies for Learning Questionnaire

	Phi Estimates for Motivation Items					
	Intr	Extr	Tskv	Cont	Slfef	Tanx
Extr	.27					
Tskv	.83	.24				
Cont	.54	.18	.45			
Slfef	.69	.26	.55	.66		
Tanx	-.18	.22	-.17	-.26	-.39	

	Phi Estimates for Learning Strategies Items							
	Rehr	Elab	Org	Crit	Meg	Tsdy	Eff	Prlm
Elab	.46							
Org	.71	.65						
Crit	.27	.76	.48					
Meg	.58	.85	.75	.73				
Tsdy	.55	.57	.59	.41	.76			
Eff	.45	.59	.48	.38	.78	.95		
Prlm	.28	.19	.28	.28	.23	.13	.07	
Hsk	.31	.23	.28	.14	.21	.20	.19	.70

Note. Intr: Intrinsic Goal Orientation, Extr: Extrinsic Goal Orientation, Tskv: Task Value, Cont: Control Beliefs about Learning, Slfef: Self-Efficacy for Learning & Performance, Tanx: Test Anxiety, Reh: Rehearsal, Elab: Elaboration, Org: Organization, Crit: Critical Thinking, Mcg: Metacognitive Self-Regulation, Tsdy: Time and Study Environment, Eff: Effort Regulation, Prlrn: Peer Learning, Hsk: Help Seeking
Table adapted from *A Manual for the Use of theMotivated Strategies for Learning Questionnaire (MSLQ)*, by Pintrich et al. (1991), p. 82 and p. 86

Appendix K: Learning Self-Regulation Questionnaire (SRQ-L)

Removed to comply with copyright.

Black, A. E., & Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: A self-determination theory perspective. *Science Education,* 84, 740-756.

Appendix L: Index of Autonomous Functioning

Removed to comply with copyright.

Weinstein, N., Przybylski, A. K., & Ryan, R. M. (2012). The index of autonomous functioning: Development of a scale of human autonomy. *Journal of Research in Personality*, *46*(4), 397-413.

Appendix M: Motivation Strategies for Learning Questionnaire (MSLQ)

Please rate the following items based on your behavior in this class. Your rating should be on a 7-point scale where 1= not at all true of me to 7=very true of me.

1. I prefer class work that is challenging so I can learn new things.
2. Compared with other students in this class I expect to do well
3. I am so nervous during a test that I cannot remember facts I have learned
4. It is important for me to learn what is being taught in this class
5. I like what I am learning in this class
6. I'm certain I can understand the ideas taught in this course
7. I think I will be able to use what I learn in this class in other classes
8. I expect to do very well in this class
9. Compared with others in this class, I think I'm a good student
10. I often choose paper topics I will learn something from even if they require more work
11. I am sure I can do an excellent job on the problems and tasks assigned for this class
12. I have an uneasy, upset feeling when I take a test
13. I think I will receive a good grade in this class
14. Even when I do poorly on a test I try to learn from my mistakes
15. I think that what I am learning in this class is useful for me to know
16. My study skills are excellent compared with others in this class
17. I think that what we are learning in this class is interesting
18. Compared with other students in this class I think I know a great deal about the subject
19. I know that I will be able to learn the material for this class
20. I worry a great deal about tests
21. Understanding this subject is important to me
22. When I take a test I think about how poorly I am doing
23. When I study for a test, I try to put together the information from class and from the book
24. When I do homework, I try to remember what the teacher said in class so I can answer the questions correctly
25. I ask myself questions to make sure I know the material I have been studying
26. It is hard for me to decide what the main ideas are in what I read
27. When work is hard I either give up or study only the easy parts
28. When I study I put important ideas into my own words
29. I always try to understand what the teacher is saying even if it doesn't make sense.
30. When I study for a test I try to remember as many facts as I can
31. When studying, I copy my notes over to help me remember material
32. I work on practice exercises and answer end of chapter questions even when I don't have to
33. Even when study materials are dull and uninteresting, I keep working until I finish
34. When I study for a test I practice saying the important facts over and over to myself
35. Before I begin studying I think about the things I will need to do to learn
36. I use what I have learned from old homework assignments and the textbook to do new assignments
37. I often find that I have been reading for class but don't know what it is all about.

38. I find that when the teacher is talking I think of other things and don't really listen to what is being said
39. When I am studying a topic, I try to make everything fit together
40. When I'm reading I stop once in a while and go over what I have read
41. When I read materials for this class, I say the words over and over to myself to help me remember
42. I outline the chapters in my book to help me study
43. I work hard to get a good grade even when I don't like a class
44. When reading I try to connect the things I am reading about with what I already know.

Appendix N: Grit-S

Removed to comply with copyright.

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: perseverance and passion for long-term goals. *Journal of personality and social psychology*, *92*(6), 1087.

Appendix O: Permission to Publish

[External] Svar: Permission to publish

Lucas Matias Jeno <Lucas.Jeno@uib.no>
Thu 8/25/2022 4:34 AM
To: Wibbeler, Jenni <jwibbeler@liberty.edu>

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

Dear Jenni,

Thank you for reaching out. From my side, you have permission to do this (and thank you for the interest in my research). I am not sure if you actually need permission from British Journal of Educational Technology (BJET) or the publisher (Wiley, I believe). Anyway, you have my permission, but make sure you ask BJET so you don't violate any copyright issues.

Good luck on you dissertation!

--
Med vennlig hilsen/Best wishes

Lucas M. Jeno, PhD

Associate Professor
Department of Education, University of Bergen
Christiesgate 13, Vektergården
NO-5015 Bergen, Norway
Mob: +47 48134643

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Fra: Wibbeler, Jenni <jwibbeler@liberty.edu>
Dato: onsdag, 24. august 2022 kl. 21:56
Til: Lucas Matias Jeno <Lucas.Jeno@uib.no>
Emne: Permission to publish

Hello,

My name is Jenni Wibbeler and I am EdD candidate with Liberty University. I have successfully defended my dissertation "A Correlational Study of Noncognitive Variables and Student Success in Dental Education" and am in the process of submitting it for publication to our online library repository, Scholar's Crossing. May I have permission to publish an amended rendering of your table *Mean Comparison Between the Study Conditions Along with Standard Deviations, F-Values and Effect Sizes (Cohen's d)* found in your article "The effects of m-learning on motivation, achievement and well-being: A Self-Determination Theory approach" in my dissertation, as well as future articles based on my dissertation research? Proper citation and credit will be given to you. I can share what the table looks like in my dissertation if you need to see it and can share any further information.

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Aug 25, 2022

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Number of figures/tables	1
Will you be translating?	No
Title	A CORRELATIONAL STUDY OF NONCOGNITIVE VARIABLES AND STUDENT SUCCESS IN DENTAL EDUCATION

Institution name	Liberty University
Expected presentation date	Aug 2022
Portions	Table 2. Mean comparison between the study conditions along with standard deviations, F-values and effect sizes (Cohen's d)
Requestor Location	Dr. Jennifer Wibbeler [redacted] [redacted] Attn: Dr. Jennifer Wibbeler
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- The failure of either party to enforce any term or condition of this Agreement shall not constitute a waiver of either party's right to enforce each and every term and condition of this Agreement. No breach under this agreement shall be deemed waived or excused by either party unless such waiver or consent is in writing signed by the party granting such waiver or consent. The waiver by or consent of a party to a breach of any provision of this Agreement shall not operate or be construed as a waiver of or consent to any other or subsequent breach by such other party.

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[External] Re: Permission to publish

Daniel Hartlep <dhartlep@umich.edu>

Thu 8/25/2022 9:22 AM

To: Wibbeler, Jenni <jwibbeler@liberty.edu>

Cc: mslq@umich.edu <mslq@umich.edu>

Hello yes you have permission to publish using the MSLQ so long as you give proper credit and citations for it.

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Daniel Hartlep *(he/him/his)*
Program Coordinator | Combined Program in Education & Psychology
(734) 763-0680 | dhartlep@umich.edu
610 E. University Ave | Room 1413

On Wed, Aug 24, 2022 at 9:47 PM Wibbeler, Jenni <jwibbeler@liberty.edu> wrote:

> Hello,
>
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>
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Dale Schunk <dhschunk@uncg.edu>

Thu 8/25/2022 1:51 PM

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On Wed, Aug 24, 2022 at 4:00 PM Wibbeler, Jenni <jwibbeler@liberty.edu> wrote:

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>
> Thank you,
> Jenni Wibbeler

--
Dale H. Schunk, Professor
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1300 Spring Garden Street
Greensboro, NC 27412
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