Teachers' Understanding of Science and

Attention Deficit Hyperactivity

Disorder

by

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ABSTRACT

This study assessed whether a better understanding of the scientific process helps facilitate the extent to which teachers are able to read, understand, and appropriately apply research on Attention Deficit Hyperactivity Disorder (ADHD) when working with students. Participants consisted of 115 teachers from Wisconsin and were surveyed using a questionnaire about their knowledge, opinions, and experiences. Results revealed 72% of the teachers surveyed were classified as having an "understanding of the scientific process" according to NSF 2002 standards. There was no difference between teachers who attained their master's degree or higher versus teachers who attained their bachelor's degree with regard to their scientific understanding. Results also indicated teachers' knowledge about the scientific process was significantly related to their ADHD knowledge, (r = .29, p < .01).

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Chapter 1: Introduction

One specific group in society that needs to be scientifically literate is teachers. From pre-kindergarten to twelfth grades teachers play a vital role in our children's lives and play a major role in referring and determining disabilities, especially attention-deficit/hyperactivity disorder (ADHD). For example, when teachers were asked to name one group (teachers, parents, school psychologists, or physicians) who most often recommended the initial assessment of ADHD, 64% indicated teachers made the initial referral (Snider, Busch, & Arrowood, 2003). School social workers also reported they perceived teachers were most likely to begin the referral process for suspected ADHD cases 58.7% of the time (Cornell-Swanson, Irwin, Johnson, Bowman, & Frankenberger, 2005). In addition, school psychologists reported teachers initiated the referrals for suspected ADHD cases 77% of the time (Frankenberger, Farmer, Parker, & Cermack, 2001). More importantly, a high percentage of those referred for ADHD are actually diagnosed as such. Once diagnosed, psychostimulant medications are the most commonly prescribed intervention and often the only intervention implemented at both home and school (Alto & Frankenberger, 1995, DuPaul, 2007; Frankenberger et al., 2001; Purdie, Hattie, & Carroll, 2002; Snider et al, 2003; Weber, Frankenberger, & Heilman, 1992). Thus, teachers may not only have the greatest impact on students before any diagnosis is actually made by a doctor or mental health provider, but their actions can have substantial implications for their students.

The vast majority of empirical research surrounding ADHD is based on a medical perspective and funded by pharmaceutical companies. Reid and Maag (as cited in DuPaul & Eckert, 1995) stated there are more than 1,000 articles assessing the effects of pharmacological interventions. On the other hand, there are fewer than 100 methodologically sound empirical articles on the effects of educational interventions and even fewer that have methodically assessed training and service requirements. This large discrepancy in the types of research being conducted (e.g., medical versus educational) is disconcerting when many teachers feel they need training in how to implement classroom interventions so they can effectively work with students with ADHD in the classroom (Carney & Gerken, 2007; Reid, Vasa, Maag, & Wright, 1994). If the majority of the research on ADHD is based from a medical perspective, this perpetuates the view that ADHD must be treated with medical interventions, not educational interventions (Snider et al., 2003).

When reviewing the ADHD literature, it is important teachers rely on empirical research to inform and direct their professional decisions (Snider et al., 2003). If we are looking to enhance academic achievement among students with ADHD or other disabilities, it is imperative teachers are not only science literate regarding these disabilities but also scientifically literate (Maienschein, 2003). Science literacy involves training teachers on specific facts and skills, whereas scientific literacy educates teachers on the importance of understanding the methods and reasoning of science, as well as the ability to think critically and creatively in their everyday surroundings (Maienschein, 2003). For example, someone who is science literate would know, based on knowledge about antibiotics, they should take the entire course of a prescribed antibiotic. However, the scientifically literate individual will question why we should take the entire course of an antibiotic, and why that antibiotic will be replaced by something else in the future.

Some teachers may have little opportunity to be scientifically literate about ADHD. For example, even though ADHD is one of the most commonly diagnosed psychiatric disorders in childhood (Carney & Gerken, 2007; DuPaul, 2007), the majority of teachers in the United States do not receive training regarding ADHD during their college education or after graduation

(Carney & Gerken, 2007). For example, Jerome, Gordon, and Hustler (1994) conducted a study in which they compared 439 American and 850 Canadian teachers' knowledge about ADHD and found both populations had received minimal educational in-service training on identifying the signs and symptoms of this disorder. Eighty-nine percent of teachers in the United States surveyed received no training at all or only a brief introduction about the disorder prior to attaining their degree. Furthermore, 92% of teachers in the United States surveyed received very little training about ADHD after attaining their college degree (Jerome et al., 1994). Research indicates there has not been much of a difference over the years regarding teachers' knowledge. Even though more information is provided to the teachers, it still has not been integrated into the curriculum. It is vital that teachers are taught specific facts and skills (i.e., develop science literacy); however, they must also be able to think analytically and resourcefully (i.e., develop scientific literacy). Clearly, more attention needs to be given to these endeavors, particularly in the United States. If teachers are educated on the importance of scientific literacy, then they will be able to discriminate between reliable scientific information versus unconfirmed claims or popular trends that colleagues may be using in their classrooms (Maienschein, 2003).

Purpose of the Study

The purpose of this study is to determine whether teachers who understand the scientific process also have a better understanding of the causes and correlates of, as well as effective interventions for, ADHD. That is, does a better understanding of the scientific process help facilitate the extent to which teachers are able to read, understand, and appropriately apply research on ADHD when working with students?

In order to answer this, I examined teachers' knowledge about the scientific process in general. It is believed that more informed consumers of research (in this case teachers) make more accurate interpretations of data and are better equipped to apply their knowledge in their work. It is hypothesized that teachers with more academic educational experience will have a better understanding of the scientific process. That is, teachers who have obtained their master's degree, as compared to a bachelor's degree, are more likely to have had coursework in the scientific method, which will help them understand and evaluate scientific research more accurately.

Next, I examined how many teachers rely on empirical research. It is hypothesized that teachers who have access to free peer-reviewed journals and those with graduate degrees will be more likely than those who do not have free access to journals or without graduate degrees to read more peer-reviewed articles. In addition, it is expected that teachers who report frequently reading peer-reviewed articles are more likely to have a better understanding of the scientific process.

I examined the extent to which teachers' understanding of the scientific process is associated with their knowledge about ADHD and their use of empirical research to help inform their decision-making. Specifically, it is hypothesized that teachers who have a better understanding of the scientific process would obtain higher scores on their knowledge about ADHD and be better equipped to apply such knowledge in the classroom.

Finally, I examined the extent to which teachers relied on empirical research to help inform their decisions in the classroom. I wanted to determine whether teachers were relying on evidence-based interventions to guide their classroom practice or some other means such as media or colleagues.

Significance of the Study

There is currently limited information regarding teachers' understanding of the scientific process and their reliance on empirical research. In addition, more research needs to be done to determine if a better understanding of the scientific process results in an increased understanding and ability to apply research regarding ADHD to their classroom practice. As stated previously, teachers play a vital role in our children's lives, and it is crucial that teachers are science and scientifically literate because they are the ones who are most likely to initiate the referral process for students suspected of ADHD, as well as spend the majority of the day with them in their classroom.

Definition of Terms

Science literate - focuses on scientific or technical knowledge (i.e., knowledge of specific facts and skills related to a specific subject matter; Maienschein, 2003).

Scientific literacy - focuses on the ability to think critically, creatively, and logically as well to make conclusions by scrutinizing and analyzing objective or empirical data (Maienschein, 2003).

Chapter 2: Literature Review

The following literature review will first describe how the understanding of the scientific process is defined as well as how it is measured. Second, a review of whether teachers are relying on empirical research to guide how they work with children and adolescents with symptoms of ADHD in the classroom. Third, literature on what is currently known about academic performance in children and adolescents with ADHD, and the research surrounding ADHD as a neurological disorder will be reviewed. Finally, interventions considered empirically valid for academic gains among children and adolescents with ADHD are examined.

Defining and Measuring Understanding of the Scientific Process

By learning the fundamentals of science (i.e., basic scientific facts, terms, and concepts), an individual is able to understand daily news reports related to scientific issues, as well as partake in public discourse involving issues related to science. Further, a clear understanding of the scientific process may be even more imperative. Knowledge regarding the process of how concepts are examined and scrutinized is a strong indication of scientific literacy. Scientific literacy is crucial not only for staying abreast of vital scientific issues, but also for determining whether the information is valid and reliable (NSF, 2001).

Scientific research often creates controversy because it usually does not produce definitive answers. The public, in this case teachers, should be educated to understand and appreciate the positive impact controversy plays in the research process, rather than regarding it as wishy-washy science, or the result of incompetent scientists. In addition, the public must be able to discern between uncertainty that results from the normal scientific process and uncertainty that stems from poor methods. For example, a research study based on double-blind, experimentally controlled methods using a large sample size is a methodologically sound study, despite the fact the research findings may not be definitive and may list more possible confounding variables than they anticipated at the beginning of the study. However, a research study that is not methodologically sound may include but is not limited to the following: based largely on survey and case study research, which includes small sample sizes, short-term implementation period, and possible response bias. In addition, studies that may not take into account other treatments participants may be receiving (e.g., medication or other therapies), not based off past research, did not use controls, or no mention of possible confounding variables. Therefore, research studies with these methodological flaws should raise a red flag regarding the reliability and validity of the study, despite the researchers' claim of concrete evidence suggesting their research is proven. In most cases, research articles published through refereed journals will be methodologically sound, because they are required to go through the peer-review process, which typically eliminates methodological and validity limitations. In short, the public should understand what the proper scientific methods are and how the peer-review process works (Field & Powell, 2001).

It is also imperative that the public has a basic understanding of how evidence is used in science to validate findings because there are many situations when the public has to sort through scientists' judgments about the presented evidence. Readers of research should be able to ask questions and discern between objective and subjective conclusions (Tytler, 2001). Shapin (1992) stated how important it is for people understand the collaborative foundation of science. In short, science is based on a collection of different scientists' research, never just one, and what is found true one day may in turn be found to be false the next day. Thus, it is crucial the public learns to critically analyze the evidence.

There have been several instruments developed to measure the public's understanding of the scientific process. However, the National Science Foundation (NSF) holds the most nationally recognized and stable system of measurement. For almost 30 years, the NSF "science indicators" measures of public attitudes and understanding of science have also incorporated a comparison with similar synchronized Japanese and European surveys. These coordinating methodologies, research protocols, and data have become the international foundation for measuring "public understanding of science" (Wynne, 1995).

The National Science Foundation (NSF) measures the public's understanding of the scientific process by using a survey of *Public Attitudes Toward and Understanding of Science and Technology* (NSF, 2001). The survey includes questions such as what is meant by studying something scientifically, evaluating drug experiments, and evaluating respondents' understanding of probability. In a recent study, the NSF randomly selected English or Spanish speaking residents age 18 years or older in households with working telephones during February through May of 2001. Their findings suggest that the majority of the surveyed adults in the United States (approximately 70%; n = 1,574) do not understand the scientific process (NSF, 2001). In 2001, over 50% of the participants in the NSF survey had at least some understanding of probability, and over 40% had some idea how an experiment is conducted; however, only 33% could coherently define how to study something scientifically. The NSF did not report a breakdown of the surveyed population according to educational level attained with respect to scientific literacy, rather they reported the statistics as a general population. The NSF considered a respondent's definition of scientific study correct if it contained descriptions such as "theory testing," "experimentation," or "rigorous, systematic explanation." In order for the participant's response to be considered "understanding of the scientific process," all of the questions relating to scientific probability must have been answered correctly and either a correct definition of a scientific study was given or a correct explanation of why it is better to test a drug using a control group was provided (NSF, 2001). Unfortunately, the results were reported with reference to the public, as a whole, making it difficult to know whether teachers would score higher than the reported public with regard to scientific literacy.

Teachers' Reliance on Empirical Data to Guide Their Classroom Practice

There is currently limited information regarding teachers' understanding of the scientific process. However, when teachers were asked to name the one source they relied on most for information about ADHD, they identified their colleagues (32%) and in-service training (25%). Only 12% of the teachers relied on professional journal articles as their main source of information regarding ADHD (Snider et al., 2003). Brook, Watemberg, and Geva (2000) found teachers primarily relied on sources such as specialized literature, special courses, and symposiums relating to ADHD, not journal articles.

If teachers are going to make objective and empirically sound decisions regarding their classroom practice, such as how to effectively help a student with ADHD, Maienschein (2003) asserts it is crucial they rely on peer-reviewed scientifically proven interventions, not unconfirmed claims or popular trends that colleagues may be using in their classrooms. However, reading vast amounts of professional journal articles can be a time-intensive process and may be unrealistic given the other expectations placed upon teachers. As a result, it is crucial when teachers are relying on colleagues, in-service training, specialized literature, special courses, and symposiums, they must be scientifically literate so they can discern between claims based on methodologically sound studies and those based on studies with methodological and validity limitations.

Sadly, there appears to be a gap in the research-to-practice or research-to-teaching connetion (Spear-Swerling and Sternberg, 2001). One possible factor regarding the lack of reliance on professional journals among teachers may be the simple fact that they have not been educated on how to become critical consumers of research. Second, it may be teachers do not have or are not given the time to read scientific literature. A third possible reason may be due to ambivalence in the field of education regarding the value of empirical data (Snider et al., 2003). Snider, Busch, and Arrowood (2003) noted one of the endeavors the teaching profession needs to address is how to become a more research-based practice. Given the high stakes of our educational system, educational decisions should be based on scientific evidence instead of popular trends or what "feels right" (Carnine, 1999; 2000). This is particularly true with interventions for students displaying ADHD behaviors.

Not only are teachers most likely to initially refer children and adolescents with ADHD, they are also most likely to spend the majority of the school day with the child (Carney & Gerken, 2007). Carney and Gerken (2007) found, in their review of the literature, if teachers were allowed to make the ADHD diagnosis, prevalence rates would be between six percent and 26% or more versus the generally accepted prevalence rate of three percent to seven percent. Teachers also have the opportunity to provide current scientific information about the disorder to colleagues as well as to the parents. Therefore, it is crucial teachers critically analyze current data in all areas of research regarding ADHD, not just easily accessed information provided through mass mailings and the Internet.

Another reason teachers may rely on professionals and colleagues for information about ADHD is because ADHD represents a larger societal issue with many competing perspectives. In fact, according to Wynne (1995), knowledge in a social content can affect how willing society (e.g., parents and teachers) is to accept empirical data. For example, it is much easier to prescribe a child medicine than it is to change the way parents and teachers handle children and adolescents diagnosed with ADHD (e.g., implementing academic and behavioral procedures). In addition, teachers and parents may ignore empirical data because they do not feel it pertains to their situation (Wynne, 1995). It may be difficult for parents and teachers to recognize that the things they do may contribute to a child's symptoms of ADHD, general functioning, and well-being. For example, they may not accept that environmental factors (e.g., the manner in which they handle a child diagnosed with ADHD) may be maintaining the inappropriate behavior exhibited by the child. It may be easier to accept that a child has a neurological or medical condition because then the parents and teachers are not held accountable and do not have to put in the energy to change current practices. Indeed, treatments that are less likely to disrupt the classroom setting, require less time to implement, and involve positive versus negative consequences are often viewed by teachers as more acceptable than interventions without these features (Fairbanks & Stinnett, 1997).

Given the vast amount of time teachers are involved with children in the classroom, it is imperative to educate and train teachers on how to effectively and efficiently implement empirically-based educational interventions so they can feel confident, thus increasing the chance they will use the interventions in the classroom. Carney and Gerken (2007) found in their review of the literature, teachers' knowledge about ADHD has not changed much over the past few years. In addition, despite increased ADHD information provided to the teachers in the last eight to ten years, information about ADHD is still not an essential piece of the curriculum used in teacher training. Further, over 80% of teachers in the field did not feel they received much training regarding ADHD in their undergraduate studies (Piccolo-Torsky & Waishwell, 1998). In addition, despite the overwhelming abundance of information regarding the most effective interventions for ADHD, the scientific findings do not always easily translate into realistic accommodations and interventions in the classroom setting for students with ADHD (Reid & Maag, 1998). Carney and Gerken (2007) found teachers do want quality training, materials, and experiences, but are not exposed to them. On the other hand, some studies have indicated teachers are often dogmatic when it comes to their beliefs regardless of the empirical evidence surrounding those beliefs (DiBattista & Shepard, 1993). Therefore, to increase the likelihood that teachers change their misperceptions, it is crucial training materials be well researched and valid, as well as targeted to the teachers' level of comprehension, not the scientific researchers' level (Kos, Richdale, & Jackson, 2004). In addition, if teachers are able to discern between methodological and valid studies, they will be less likely to rely so heavily on information from the media (Snider et al., 2003), resulting in fewer teachers practicing and believing in treatments that have no empirical support.

Academic Performance in Children with ADHD and Research Surrounding Neurological Basis of ADHD

In the classroom, students diagnosed with ADHD have difficulty maintaining attention to tasks, following instructions, completing assigned work, and obeying the general classroom rules. Given these difficulties, one of the greatest risks for students with ADHD is academic underachievement (Ervin, DuPaul, Kern, & Friman, 1998; DuPaul, 2007). Even though psychostimulant medications are the most commonly used intervention for individuals diagnosed with ADHD, they alone do not contribute to academic gains in students with ADHD, even after one to two years of treatment (DuPaul, 2007). According to Stanton and colleagues (2002), there are no empirical data supporting that psychotropic medications improve learning in the long-term. Similarly, Frankenberger and Cannon (1999) conducted a longitudinal study on academic gains in students with ADHD who were taking psychostimulants (e.g., Ritalin) versus their classroom peers in first to fifth grade. They found, compared to their classroom peers, students with ADHD were functioning at lower academic and cognitive levels before they started taking medication. Further, after medication was started and doses were continually increased over the years, the students with ADHD taking stimulant medication continued to score significantly lower with regard to academic performance, especially by fifth grade. These findings suggest that psychostimulant medications alone do not help children catch-up on foundational skills they originally lost. Indeed, Frankenberger and Cannon (1999) also found that only 38% of the students receiving psychostimulants participated in any other interventions (i.e., educational or behavioral).

Although advocacy groups and information dispersed by Children and Adults with Attention-Deficit Hyperactivity Disorder (CHADD, 2004) and the pharmaceutical industry indicate ADHD is a result of a neurological disorder, the empirical data is inconclusive. That is, the wide variety of causes and how these causes intermix to make up this disorder of ADHD is, at best, complicated (Snider et al., 2003). As a result, the public, in this case teachers, should be researching and implementing empirically validated interventions that promote academic gains in children with ADHD.

According to Leo and Cohen's (2003) review article of neuroimaging studies, the scientific research surrounding ADHD and neuroimaging is disconcerting because of a significant confounding variable (prior or concurrent medication use by participants diagnosed with ADHD) found in the majority of the studies. In these studies, researchers attempted to look at differences in the brain using brain scans of people who were diagnosed with ADHD and taking stimulant medication versus brain scans of normal control participants (e.g., without a diagnosis of ADHD). Most research indicates there is a difference between the brain images of the two groups. For example, the children and adolescents with ADHD appeared to have smaller brains overall than children and adolescents without ADHD (Castellanos et al., 2002). However, the real question is whether the differences are a result of brain changes due to prior medication usage or are biologically based. Research has shown prior medication use is a crucial confounding variable that causes the validity of these studies to be questioned; however, the majority of researchers still use medicated participants in their studies, sometimes without even mentioning the participants are currently taking, or have taken, psychostimulant medication (Leo & Cohen, 2003).

The National Institute of Mental Health (NIMH) sponsored a large study conducted by Castellanos and colleagues (2002), which compared subgroups of 103 medicated and 49 nonmedicated participants with ADHD. These results indicated there was a statistically significant difference with regard to brain size between the medicated and nonmedicated participants with ADHD versus the normal control group. Results suggested the participants with ADHD, regardless of medication use, had smaller brain volumes than their peers. Interestingly, Leo and Cohen (2003) noted several serious methodological flaws with Castellanos and colleagues' (2002) study. First, the non-medicated participants with ADHD were on average two years younger than the medicated participants with ADHD. Second, the non-medicated participants were stated to be smaller in height as well as weighing less than the normal controls; however, the exact figures on height and weight were not included. Third, no information was provided regarding treatment histories of the participants with ADHD who were taking medication (i.e., dosage, duration, or what specific drug was being taken). Despite these serious methodological flaws associated with the Castellanos and colleagues' (2002) study, the NIMH held a press release in 2002 stating "*Brain Shrinkage in ADHD Not Caused by Medications*" (as cited in Leo & Cohen, 2003). This press release questions why certainty was presented to the public rather than stating the confounding variables and uncertainty surrounding the research findings.

One year later, Cohen and Leo (2004) did another critical analysis of newly published neuroimaging studies and found similar methodological flaws. For example, Mostofsky, Cooper, Kates, Denckla, and Kaufmann (2002) conducted a study comparing frontal lobe gray and white matter brain volumes in participants with ADHD versus participants with no history of neurological or psychiatric disorders; however, 10 of their 12 participants had a history of prior stimulant medication use for ADHD. In addition, MacMaster, Carrey, Sparkes, and Kusumakar (2003) claimed to use medication-free participants when assessing metabolite levels in the prefrontal cortex of children and adolescents with ADHD versus participants with no psychiatric illness. Interestingly, they even used the term "medication-free" in the title of their article. However, eight of their nine participants had a prior history of medication: three participants discontinued their medication 48 hours before the brain imaging, and five participants discontinued their medication one to three weeks before the brain imaging. Only one participant had not been taking stimulant medication prior to the brain imaging. Discontinuing medication for participants with ADHD before the brain scanning is conducted and then labeling them as "medication-free" in the study is unsound and extremely disconcerting (Cohen & Leo, 2004).

In addition, Cohen and Leo (2004) point out another recent study with questionable methodology. In a study published in the *Lancet,* Sowell and colleagues (2003) assessed cortical abnormalities in children and adolescents with ADHD. They failed to provide important details regarding their medication-free participants, such as whether or not the non-medicated participants had a *prior* history of stimulant medication. In addition, Sowell and colleagues (2003) acknowledge because over half of their participants with ADHD were currently taking stimulant medication, this may have been a potential confound in their findings of differences in brain structure in children and adolescents with ADHD versus medication-free children and adolescents. However, rather than compare the groups of participants who were supposedly non-medicated to those who were medicated, Sowell and colleagues purposely chose not to make the comparison because they stated that Castellanos and colleagues (2002) indicated stimulants do not alter brain mass despite the methodical flaws that were noted in Leo and Cohen's (2003) review, which was published before their study. The scientific process involves systematic replication, not single case findings determining absolute evidence. Ironically, just like the Castellanos and colleagues (2002) study, this study received mass media attention (Cohen & Leo, 2004). If the public (in this case teachers) had a strong basis in the understanding of the scientific process, this would help them make sense of these findings (i.e., understand the limitations, as well as ways in which research advances knowledge).

The National Institute of Mental Health (NIMH) supports much of the highly publicized research claiming children and adolescents with ADHD showed three to four percent smaller brain volumes in the frontal lobes, temporal gray matter, caudate nucleus, and cerebellum (Castellanos et al., 2002). However, in a recent review of 74 studies relating to research on interventions for ADHD, the causes of ADHD were found to be unknown or mixed (psychosocial, biological, hereditary; Purdie et al., 2002). In addition, as Cohen and Leo (2003, 2004) pointed out, the research leading to evidence of neurological abnormalities in children and adolescents with ADHD contain serious methodological flaws that raise serious concerns regarding what is being allowed to be published through the peer review process. The uncertainty in the ADHD research, as well as the methodological flaws, should be presented as such to the public. In addition, teachers should be able to sift through the methods to discern whether the research is valid and reliable. In turn, if teachers are able to understand the limitations of the research as well as the advances made, they may be more willing to further investigate other treatment options such as educational interventions, rather than relying only on medical-based interventions (Alto & Frankenberger, 1995, DuPaul, 2007; Frankenberger et al., 2001; Purdie, Hattie, & Carroll, 2002; Snider et al, 2003; Weber, Frankenberger, & Heilman, 1992).

Effective Interventions for Academic Gains

According to the research on ADHD regarding effective interventions, the most commonly reported type of treatment for ADHD is a pharmacological intervention, such as Ritalin or Adderall (Alto & Frankenberger, 1995, DuPaul, 2007; Frankenberger et al., 2001; Purdie et al., 2002; Snider et al, 2003; Weber et al., 1992). Purdie, Hattie, and Carroll (2002) found stimulants have an effect on attention, concentration, and motivation, but have found no evidence showing an effect on academic performance or cognition. This lack of academic progress suggests the importance of implementing educational interventions, which have been shown to not only increase academic skills but in some cases also improve attentive, reflective behavior (DuPaul, 2007). Although 70% to 80% of the children and adolescents on medication show some signs of improvement in regard to their impulsiveness and disruptive social behavior, they remain one standard deviation above the norm with respect to problems with interpersonal relationships with their peers. Despite the short-term positive outcomes of some target behaviors (e.g., on-task behavior in class, disruptive social behavior, and negative peer interaction) there are no known empirical data indicating long-term academic increases for students receiving psychostimulant medications or significant modifications in negative peer interactions (Pelham, Wheeler, & Chronis, 1998). In short, this means medicated children and adolescents with ADHD still may be experiencing higher levels of problem behaviors (i.e., impulsiveness, inattention, hyperactivity) than their non-medicated peers. It is important for teachers to understand this so they can structure their classrooms using educational interventions that will enable an environment more conducive to learning for children with ADHD who are receiving medication, as well as the rest of the students in the classroom.

As stated earlier, once diagnosed, psychostimulant medications are the most commonly prescribed intervention and often the only intervention implemented at both home and school (Alto & Frankenberger, 1995, DuPaul, 2007; Frankenberger et al., 2001; Purdie, Hattie, & Carroll, 2002; Snider et al, 2003; Weber, Frankenberger, & Heilman, 1992). Teachers may be more likely to support medical interventions as opposed to educational or behavioral interventions is because teachers may be assuming a medical intervention is the most efficient treatment for ADHD because they are not critically analyzing the peer-reviewed scientific research. Teachers know children who are referred for ADHD often are taken to their doctor and prescribed medication, so they may be under the assumption that because there is a neurological basis for ADHD, the medical intervention is suffice. Furthermore, the NSF (2002) stated that more people expressed interest in medicine than any other subject; in fact, not only were two-thirds of their survey respondents very interested in new medical discoveries, but they also strongly supported government-sponsored medical research. These findings suggest society often relies on medicine to “cure” the majority of our disabilities and illnesses. For instance, Type II diabetes is an example of society's reliance on medicine (e.g., insulin versus exercise and diet).

Vereb and DiPerna (2004) found teachers who received in-service training regarding ADHD were most likely to retain information relating to the specific features of ADHD rather than potential interventions. They also found teachers' years of teaching experience with children and adolescents with ADHD did not correlate with their knowledge of ADHD; however, teachers who had more years of teaching experience tended to rate medical interventions as more acceptable than those teachers with fewer years of teaching experience. Vereb and DiPerna (2004) posited, as teachers' classroom experience increased, they were more likely to accept medical interventions over other types of interventions because of the increased exposure to medical interventions since these are the mostly commonly prescribed interventions (Alto & Frankenberger, 1995, Frankenberger et al., 2001; Purdie et al., 2002; Snider et al, 2003; Weber et al., 1992).

As far as research related to academic progress for children with ADHD, Purdie and colleagues (2002) found educational interventions had the greatest effect on academic gains in this population. They analyzed 74 different studies in which there had been an intervention designed to improve the behavioral, cognitive, and social functioning for children and adolescents. Educational interventions had a significantly greater effect size (.58) than pharmacological interventions (.36) regarding in-class achievement (Purdie et al., 2002).

Educational interventions consist of general school and teacher procedures such as inclusive practices, team approaches, service plans, family involvement, and specific academic interventions. These interventions include, but are not limited to, sitting the child with ADHD in front of the classroom, providing frequent breaks between educational tasks, structuring the classroom more formally than informally, allowing the child to fidget with a manipulative such as a pipe cleaner during class, and reducing extraneous noise in the classroom. Further, school-based methods focus on behavioral interventions that include self-management, social skills training, cooperative learning, and peer tutoring (Barry & Messer, 2003; McMullen, Painter, & Casey, 1994).

Educational interventions have been found to be the most effective intervention when it comes to increasing academic gains for students with ADHD (e.g., token economies using response cost, computer assisted instruction, class-wide peer tutoring, homework support, self-regulated strategy for written expression, directed note-taking, and home-school communication program; DuPaul, 2007), so it is imperative teachers know how to use the strategies that can help achieve success in students who are diagnosed with ADHD. Not only do educational interventions help the teacher control classroom behavior, they also have a positive effect on students' actual academic performance, unlike pharmacological interventions (Barry & Messer, 2003).

First, it is hypothesized that teachers with more academic educational experience will have a better understanding of the scientific process. That is, teachers who have obtained their master's degree, as compared to a bachelor's degree, are more likely to have had coursework in the scientific method, which will help them understand and evaluate scientific research more accurately.

Second, it is hypothesized that teachers who have access to free peer-reviewed journals and those with graduate degrees will be more likely than those who do not have free access to journals or without graduate degrees to read peer-reviewed articles. In addition, it is expected that teachers who report frequently reading peer-reviewed articles are more likely to have a better understanding of the scientific process.

Third, it is hypothesized that teachers who have a better understanding of the scientific process would obtain higher scores on their knowledge about ADHD and be better equipped to apply such knowledge in the classroom.

Chapter III: Method

The methods and procedures used in this study of teachers and their understanding of ADHD and the scientific process are explained in this chapter under the headings of (1) research design, (2) data collection procedures, (3) sample selection, and (4) instrumentation.

Research Design

The approach to this study was quantitative, using a survey methodology, with a primary goal of assessing whether a better understanding of the scientific process helps the extent to which teachers are able to read, understand, and appropriately apply research on ADHD when working with students.

Data Collection Procedures

Four hundred K-12 teachers were randomly selected through Wisconsin's Department of Public Instruction's website. A cover letter (Appendix A) explaining the purpose of the study and assuring anonymity was distributed along with the questionnaire. The questionnaires were sent to the teachers' school addresses. Teachers were instructed via the cover letter to place their completed questionnaires in the self-addressed envelope. There was no method built into the study to identify individuals who chose not to participate. Three weeks after the initial distribution of the survey, 100 of the 400 original participants were randomly selected and a short reminder was distributed to encourage recipients to respond to the survey if they had not yet done so. The reminder letter served to encourage those who had not yet responded to complete and return the survey, and thank them if they had.

Prior to data collection, the survey was pilot-tested on a group of local K-12 teachers. The pilot-test confirmed the survey took 10-20 minutes to complete. Minor changes (e.g., changing to clarify the meaning of a question so it would be less ambiguous) in wording were made in response to written and verbal feedback from the pilot group. For instance, question two (Appendix B) was a revised and a clearer version of Snider et al.'s survey question (e.g., "There are data to indicate that ADHD is caused by a brain malfunction" [Snider et al., 2003]) was changed to the statement, "There are *convincing and reliable* data to indicate that ADHD is caused by a brain malfunction."

In order to enhance reliability, we (a trained assistant and I) calculated inter-rater agreement for the open-ended questions (questions 23 & 24; Appendix B) by dividing the number of agreements by the number of agreements and disagreements and multiplying by 100%. The inter-rater agreement averaged 93% across all open-ended items. The assistant was trained by reviewing the NSF's sample responses that were categorized into correct and incorrect responses. In addition, five example responses were conducted prior to assessing the actual data to allow for discussion and clarification. The assistant was blind to the study's objectives and hypotheses.

Sample Selection

Of the 400 surveys distributed, 13 were returned as "undeliverable" and 11 were returned blank. Therefore, 126 of the 387 surveys were sent back to the researcher for an overall return rate of 33%. The response rate for fully completed surveys was approximately 29%.

Participants with completed surveys were 115 kindergarten through twelfth grade (K-12) general and special education teachers from Wisconsin. There were 94 female and 20 male respondents. Thirty-seven teachers (32%) attained a bachelor's degree, and 77 (67%) attained a master's degree. Forty-six (40%) of the teachers who completed the questionnaire indicated they taught general education; 62 (54%) of the teachers taught special education; three (3%) of the teachers indicated they taught both classes. Thirty-five (30%) teachers were at elementary level; 29 (25%) were junior high teachers, and 50 (44%) were high school teachers. Respondents had a mean of 16.04 (*SD* = 9.48) years of teaching experience, and a range of 1-38 years of experience (see Table 1 for a description of the sample).

Instrumentation

A three-page questionnaire with 34 questions was designed based upon previous surveys that measured the public's understanding of science (NSF, 2002). The surveys developed to measure teachers' and school psychologists' knowledge, opinions, and experiences regarding ADHD (Frankenberger et al., 2001 & Snider et al., 2003).

ADHD Knowledge. Respondents were asked to rate knowledge statements about the ADHD process (e.g., "Diagnosis of ADHD can be confirmed if stimulant medication improves his/her attention.") using a 5-point Likert scale (*1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree*; Frankenberger et al., 2001 & Snider et al., 2003). The survey consisted of eight knowledge questions (items 1, 2, 4, 6, 7, 8, 11, & 12; Appendix B). Means for each item across all teachers were computed. If the mean for a statement was 3.50 to 3.99, it was categorized as "tendency to agree." When a mean was between 4.00 and 5.00, it was labeled "agree." When a mean was between 2.49 to 2.01 it was labeled "tendency to disagree." Means of 2.00 or below were labeled "disagree." When mean scores for questions were between 2.50 and 3.49, they were considered to be within the neutral range and are generally not discussed in the results unless they represented important contrast between comparable questions (see Frankenberger et al., 2001 for a review of procedures). The knowledge questions were all based on past research (Frankenberger et al., 2001; Purdie et al., 2002; Snider et al., 2003). Although the survey assessed teachers' factual knowledge about the characteristics, symptoms, diagnosis, and treatment of ADHD, a Likert scale was used rather than a true or false format to increase the probability that responses reflected knowledge (or lack of knowledge) rather than guessing (Snider et al., 2003). Statements were recoded such that all higher scores (more agreement) reflected greater ADHD knowledge, whereas lower scores (disagreement) reflected less or inaccurate knowledge about ADHD.

ADHD Opinions. Respondents were asked to rate opinion statements about the ADHD process (e.g., "ADHD can be reliably diagnosed via collecting behavioral data in the classroom.") using a 5-point Likert scale (*1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree*; Frankenberger et al., 2001 & Snider et al., 2003). The survey consisted of five opinion statements (items 3, 5, 9, 10, & 13; see Appendix B). The mean for each item across all teachers was computed. If the mean for a statement was 3.50 to 3.99, it was labeled "tendency to agree." When a mean was between 4.00 and 5.00, it was labeled "agree." When a mean was between 2.49 to 2.01 it was labeled "tendency to disagree." Means of 2.00 or below were labeled "disagree." When mean scores for questions were between 2.50 and 3.49, they were considered to be within the neutral range and are generally not discussed in the results unless they represented important contrast between comparable questions (Frankenberger et al., 2001). The opinion questions were all based on past research (Frankenberger et al., 2001).

Scientific Process Knowledge. Frankenberger et al.'s (2001) methods were modified to measure respondents' knowledge regarding the scientific process using past research (Johnson & Slovic, 1995; Miranda, Presentaciyn, & Soriano, 2002; NIH Consensus Statement, 1998). Respondents were asked to rate knowledge statements about the scientific process (e.g., "Scientific research gets rid of the uncertainty in science.") using a 5-point Likert scale (*1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree*; Frankenberger et al., 2001 & Snider et al., 2003). The survey consisted of four knowledge statements (items 16, 19, 20, & 21; see Appendix B). Statements were recoded such that higher scores (more agreement) reflected greater scientific knowledge, whereas lower scores (disagreement) reflected less or inaccurate knowledge about the scientific process. The mean for each item across all teachers was computed. If the mean for a statement was 3.50 to 3.99, it was labeled "tendency to agree." When a mean was between 4.00 and 5.00, it was labeled "agree." When a mean was between 2.49 to 2.01 it was labeled "tendency to disagree." Means of 2.00 or below were labeled "disagree." When mean scores for questions were between 2.50 and 3.49, they were considered to be within the neutral range and are generally not discussed in the results unless they represented important contrast between comparable questions (Frankenberger et al., 2001).

There were also a series of open-ended knowledge questions taken from the public's understanding of science survey (e.g., questions 22-25; Appendix B; National Science Foundation, 2002). Questions 23-25 (Appendix B) were replicated from the National Science Foundation (NSF) survey and labeled as correct or incorrect according to the NSF's guidelines. The NSF considers a correct definition of a scientific study if it contains descriptions such as "theory testing," "experimentation," or "rigorous, systematic explanation." In order for a response to be considered "understanding of the scientific process," question 25 must be answered correctly (relating to probability) *and* a correct response must be given for either question 23 (the definition of a scientific study) or question 24 (rationale for testing a drug using two groups). The NSF considered a "correct" explanation for why it is better to test a drug using two groups versus one larger group if it described the importance of a control group.

Experiences and access/to use of research. Several questions designed by this researcher to measure teachers' experiences were also included (e.g., questions 26, 27, 28, 29, & 32; Appendix B). These questions asked teachers to indicate how often they attended ADHD trainings, read a peer-reviewed journal, searched a research database, and whether or not they have free access to peer-reviewed journals. Questions 27 and 28 specifically related to teachers' experiences reading journal articles and searching databases; they were recoded so higher scores indicate more experience with reading journal articles and searching databases. Question 29 was also recoded to reflect free access to journal articles at the higher end, as well

Demographic Data. Finally, teachers were asked to provide demographic information (e.g., questions 30, 31, 33, & 34; Appendix B), such as the grades they teach (e.g., elementary, middle school, or high school), their gender, the kind of class they teach (e.g., special education or general education), their highest educational degree attained, as well as their number of years of teaching experience.

Chapter IV: Results

This study was implemented to determine teachers' understanding of the scientific process and their knowledge of ADHD. This chapter presents the results of the study in relation to each research question.

Teachers' Level of Scientific Knowledge

In order to address the first research question and examine teachers' knowledge about the scientific process, frequencies and means were calculated for the items comprising Scientific Process Knowledge. As can be seen in Table 2, teachers tended to agree with the statement, "By the time scientific studies finally reach the media, we can *not* safely assume the information is true" (M = 3.80; SD = .81). However, teachers tended to disagree with the statement, "Uncertainties and ambiguities are *not* the result of incompetent scientists" (M = 2.14, SD = .83). Responses were in the neutral category for statements, "Scientific research *does not* get rid of uncertainty (M = 2.68, SD = .95), as well as science is *not* the generator of certainty when it is properly conducted" (M = 3.00, SD = .91). According to the NSF's definition of understanding of the scientific process, which was calculated according to correctly answered items 25 (relating to probability) and either 23 (the definition of a scientific study) or 24 (rationale for testing a drug using two groups), 81 of the 113 (72%) teachers surveyed were classified as having an "understanding of the scientific process."

Next, in order to examine whether more highly informed teachers or those with a master's degree or higher have a better understanding of the scientific process than teachers with a bachelor's degree, a chi-square analysis was conducted. The percentage of master's-level teachers who correctly answered items 25 and either 23a or 24a was compared to the percentage of bachelor's-level teachers who correctly answered the same items. There was no difference between teachers who attained their master's degree or higher versus teachers who attained their bachelor's degree $\chi^2(1, N = 113) = .43, p = .51$.

Next, using a similar procedure, teachers who reported frequently using research were compared to those who reported that they do not use research. The purpose of this analysis was to determine if teachers who relied on the use of empirical research were more accurate in their understanding of the scientific process. In order to do this, the frequency and means for items 27 and 28 were calculated. Thirty-five percent of teachers ($n = 40$) reported reading peer-reviewed articles "once a year," 27 % ($n = 31$) reported "twice a year," 14 % ($n = 16$) reported "once a month," and 19 % ($n = 22$) reported reading peer-reviewed articles "once a week." In addition, 28% ($n = 32$) of the total sample reported searching data-bases. Of those who searched data-bases, 19% ($n = 22$) reported "twice a year," 15 % ($n = 17$) reported "once a month," 30 % ($n = 34$) reported searching data-bases "once a week." On average, teachers reported reading peer-reviewed articles approximately "twice a year" ($M = 3.18$, $SD = 1.14$) and searching data bases between twice a year and once a month ($M = 3.50$, $SD = 1.23$). Next, a chi-square analysis was conducted to see if the teachers who spent more time searching data-bases and reading peer-reviewed articles were more likely to have an accurate understanding of the scientific process. Findings indicate that teachers' use of data-base searches, $\chi^2(3, N = 104) = 5.25, p = .15$, and the number of times they read peer-reviewed articles, $\chi^2(3, N = 108) = 1.03, p = .79$, were not significantly related to their understanding of the scientific process.

To examine whether teachers who have obtained their master's degree, as compared to a bachelor's degree, will be able to better understand and evaluate scientific research more accurately, mean levels of Scientific Process Knowledge were compared across groups. An ANOVA was computed with teachers' education level serving as the independent variable, and the items comprising Scientific Process Knowledge served as the dependent variables. Results indicate there are no significant differences between teachers with their master's versus bachelor's degrees on their knowledge of the scientific process, $F(1, 110) = .32, p < .57$

Use of Empirical Knowledge to Make Decisions

The next goal of this study was to examine the extent to which teachers relied on empirical research to help inform their decisions in the classroom. To determine this, the extent to which teachers have *free access* to journals was first examined. Fifty-one percent ($n = 59$) of the teachers reported having free access to peer-reviewed journals, 22% ($n = 25$) reported not having free access, and 25% ($n = 29$) reported they did not if they were provided free access to peer-reviewed journals. See above for descriptive statistics regarding teachers who read peer-reviewed journals and those who search data-bases.

Next, in order to examine if access to free peer-reviewed journals and highest level of education would be associated with teachers' *use* of peer-reviewed articles, several chi-square analyses were conducted. Results indicate that free access to journals was significantly related to teachers' reports of how often they actually read peer-reviewed articles $\chi^2(6, N = 108) = 21.81, p = .00$. In addition, free access to journal articles was also associated with teachers' use of searching data-bases $\chi^2(6, N = 104) = 16.33, p = .01$. Second, teachers' level of education (Master'sversus Bachelor's) was moderately related to how often they reported reading journal articles $\chi^2(3, N = 109) = 6.48, p = .09$., but not significantly related to their reports of searching data-bases $\chi^2(3, N = 105) = 2.99, p = .39$.

Next, teachers' use and knowledge of empirically-based information and the scientific process relate to their understanding of problems associated with ADHD seen in the classroom (i.e., ADHD) and inform their practices were examined. The frequencies and means were calculated for the items comprising ADHD Knowledge and ADHD Opinions. As can be seen in Tables 3 and 4, teachers agreed with the statements, "Inattention or inappropriate behaviors may be explained by factors other than ADHD. For example, behaviors may be maintained by the need to obtain something (e.g., attention from peers or teacher) or to avoid something (e.g., school tasks)" ($M = 4.52$, $SD = .75$); "Improving behavior (impulsivity, hyperactivity, and inattention) of ADHD students *does not* improve their emotional well-being and school-based achievement" ($M = 4.16$; $SD = .80$). Teachers tended to agree with the statements, "Once a student's pathological learning behaviors such as impulsivity, inattention, and hyperactivity are decreased, his/her general cognitive abilities will *not* improve as well" ($M = 3.55$, $SD = 1.02$); "I encourage/praise a hyperactive student frequently and immediately; He/she needs more positive remarks than other students in order to have a good performance" ($M = 3.50$, $SD = 1.00$). Teachers neither agreed nor disagreed with the remaining survey statements assessing knowledge of ADHD (see Table 3).

Teachers opinions neither agreed nor disagreed with the following statements: "ADHD can be reliably diagnosed via collecting behavioral data in the classroom (e.g., time sampling, interval recording; $M = 3.05$, $SD = .96$); A behavioral assessment followed by reasonable interventions (i.e., token economy, time-out, peer tutoring, positive reinforcement) should be sufficient to address many classroom behaviors without a referral for ADHD ($M = 3.20$, $SD = 1.05$); I usually ask the student with ADHD to evaluate his/her own performance after finishing school tasks, and I also give feedback regarding specific criteria of this evaluation ($M = 3.15$, $SD = .94$); Medical interventions (i.e., prescription drugs) are more scientifically valid than non-medical interventions (e.g., educational) when it comes to dealing with children with ADHD" ($M = 2.67$, $SD = .90$).

Finally, in order to examine the extent to which teachers' use of empirically-based information and their understanding of the scientific process is associated with their knowledge about ADHD, I computed several correlation coefficients. Findings indicate that reading peer-reviewed articles was not significantly related to teachers' knowledge about ADHD (r = -.00, $p < .99$). However, teachers' knowledge about the scientific process was significantly related to their ADHD knowledge, (r = .29, $p < .01$).

Next, using a one-way ANOVA, teachers who accurately answered items 25 and either 23 or 24 (Understanding of the Scientific Process) were compared to those who inaccurately answered these items on their ADHD knowledge. Findings indicate no differences between teachers who accurately answered these items (M = 12.65; SD = 2.62) from those who did not accurately answer these items (M = 12.69; SD = 2.53) on their knowledge of ADHD, F (1, 110) = .00, p = .94.

Chapter V: Discussion

General Findings

The purpose of this study was to determine whether teachers who understood the scientific process also had a better understanding of the causes and how they are associated, as well as the empirically validated ADHD interventions. In other words, did a better understanding of the scientific process have an effect on teachers' experiences related to reading, understanding, and appropriately applying research on ADHD when working with students in the classroom?

More than half (72%) of the teachers surveyed had an "understanding of the scientific process," based on the National Science Foundation (NSF) criteria. Even though this percentage is more than double that of the general public (30%; NSF, 2002), it is still disconcerting considering teachers have a college education, and 67% of the teachers surveyed in this study reported having a master's degree. However, this finding may reflect the difficulties associated with using the NSF criteria. More specifically, questions 23 and 24 (Appendix A) were difficult to categorize objectively as either "correct or incorrect" based on the NSF's methods. For example, the NSF considers a correct definition of scientific study if it contains descriptions such as "theory testing, experimentation, or rigorous, systematic explanation" (NSF, 2002). In addition, the NSF considered a "correct" explanation for why it is better to test a drug using two groups versus one larger group if the response included the words "control group." However, these are limited and vague descriptions of the scientific process, which may raise concerns about the reliability and validity of these two questions. In order to try and establish reliability, another rater was used in this investigation. Previous researchers have also noted limitations to the NSF criteria. Wynne (1995) questioned what these measures actually mean and how politics play in such research. Wynne (1995) stated in other surveys that asked more specific and direct questions about the scientific process (i.e., statistical tests or clinical trials), scores tended to be higher. This was true in the present study where teachers scored much higher on the likert-scale items assessing the clinical trial and probability than the open-ended question asking for the definition of what it means to study something scientifically.

Interestingly, the teachers surveyed in this study tended to agree by the time scientific studies finally reach the media, we can *not* safely assume the information is true; however, according to Snider et al. (2003), teachers indicated a heavy reliance (48%) on the media for information regarding ADHD. Teachers also tended to disagree with the statement, "uncertainties and ambiguities are *not* the result of incompetent scientists." In addition, teachers' responses to the other two statements relating to the understanding of the scientific process were neutral (e.g., "scientific research gets rid of uncertainty," and "science is the generator of certainty when it is properly conducted"), indicating teachers may not be clear on how uncertainty in science should be viewed. Taken together, these findings raise questions about teachers' understanding of the scientific process. More specifically, teachers appear unsure about what exactly they can and can not glean from scientific research. For example, when research does not provide definitive answers, such is the case with much of the ADHD research, they may view the research as invalid and only pay attention to the research that claims definitive answers, despite the fact it may actually be science based on methodological and validity flaws. Piccolo-Torsky and Waishwell (1998) found the vast majority of teachers believed ADHD was a valid special education problem or diagnosis, which leads to the assumption they believed in treatment/interventions for children with ADHD. However, three-fourths of the teachers believed that changing the diet of a child with ADHD would be beneficial, despite lack of empirical support. These results suggest teachers are willing to endorse treatment/interventions that are presented with certainty whether through word-of-mouth or popular sources (e.g., Internet, television, newspaper media) because there has never been empirical support for diet as an intervention for ADHD.

Education has been slow to evolve to a point where educational decisions are based on research rather than on what is popular or what feels good (Carnine, 1999, 2000). If teachers are able to review professional journals and discern between uncertainty that results from the typical scientific process versus uncertainty that results from unsound methods, then they will have achieved scientific literacy, which will in turn help them in their professional decision-making involving children and adolescents. It is important teachers understand science does not always produce definitive answers and are able to discriminate for themselves what is objective research (Field & Powell, 2001). In addition, they need to realize much of science incorporates the scientists' judgments regarding the empirical data. Teachers should, therefore, be educated so they can objectively critique the methods and data for themselves before assuming the research is valid (Tytler, 2001).

In line with this belief that education is the key to teachers' understanding of the scientific process, it was hypothesized that teachers with more educational experience would be scientifically literate. In contrast to expectations, although 68% of the teachers surveyed in this study had their master's degree, there was not a significant difference in their understanding of the scientific process when compared to teachers who had their bachelor's degree. These findings suggest that it is not necessarily the "amount" of education teachers have received, but perhaps the "content" of the education instead.

Interestingly, teachers tended to disagree with the statement, "By the time scientific studies finally reach the media, they can safely assume the information is true." Although this is promising, on average, teachers reported only searching research databases between twice a year and once a month and reading peer-reviewed journals approximately twice a year. In addition, almost half of all teachers surveyed stated they either were not provided free access to journal articles, or they did not know if they were provided free access. Not surprisingly, results indicated free access to journals was significantly related to teachers' reports of how often they actually read peer-reviewed articles and their use of searching data-bases. These findings indicate the importance of school districts to provide free access to journal articles because teachers are more likely to be consumers of empirical research if they are provided the resources. Results also suggest more educated teachers (e.g., master's level versus bachelor's level) tend to be more likely, but not significantly likely, to read journal articles. This result lends support to continuing education.

When teachers were surveyed regarding their knowledge and opinions regarding ADHD, they correctly stated, "Inattention or inappropriate behavior may be explained by factors other than ADHD." Teachers, therefore, appear to be aware that behavior may be maintained by the need to obtain something (e.g., attention from peers or teachers) or to avoid something (e.g. school tasks; O'Neil, Homer, Albin, Sprague, Story, & Newton, 1997). However, teachers' responses were neutral with the statement, "A behavioral assessment followed by reasonable interventions should be sufficient to address many classroom behaviors without a referral for ADHD" (O'Neil et al.). These contradictory responses suggest that teachers are unable to analytically recognize that if attention or escape is maintaining the inappropriate behavior then behavioral interventions (not medication) implemented in the classroom will eliminate inappropriate behaviors (DuPaul, Ervin, Hook, & McGoey, 1998; Ervin et al., 1998; O'Neil et al.). Teachers need to be able to discriminate misbehavior from a psychiatric disorder and have the skills to implement nonpharmacological interventions for everyday misbehavior (Snider et al., 2003).

Another possible reason for the inconsistency between responses in these two statements could be teachers do realize that inappropriate behaviors may be maintained by attention, but may be less willing to implement behavioral interventions in the classrooms for several reasons. First, as suggested by the findings, most teachers in this study conduct data searches and read empirical research rather infrequently, indicating they may be unaware of the effectiveness of behavioral interventions. Second, behavioral interventions in the classroom may be perceived by teachers as unduly time-consuming and would cut into their prep time. These factors taken together are likely to contribute to teachers relying on medical interventions.

Turney (1996) stated there is often resistance to receiving scientific information especially if there is a medical treatment available. People often feel there would not be a medical treatment unless it had an effective outcome. Turney (1996) also says people often feel they have no choice except to trust those who are more educated than they are (i.e., doctors receive far more schooling than teachers). The educational level and perceived expertise of the doctors could be why pharmacological interventions are used more often than nonpharmacological interventions. It may be that teachers do not read research on learning disabilities because they feel it is up to the experts in the medical field. Thus, if teachers read scientific information they may be less likely to recommend stimulant medications (Borgschatz, Frankenberger, & Eder, 1999).

Taken together, the results of this study suggest teachers do not rely on all of the scientific evidence when obtaining information regarding various learning disabilities and the role they can play in implementing interventions. Reid and Maag's study (as cited in DuPaul & Eckert, 1995) found most of the research regarding ADHD is based primarily from the medical perspective, resulting in the assumption that treatment should be based solely on the use of medication. These results indicate many teachers not only appear to have limited access to empirical research, but also when they do get information about ADHD, it is likely to be from the medical perspective or popular sources (e.g., the media or co-workers), thereby decreasing the likelihood they will try classroom-based educational approaches. It is also possible that the type of training teachers receive about ADHD and the material presented will determine how they will structure their classrooms. Teachers not only need to be trained on the symptoms of ADHD, but also on which interventions are effective for academic gains in the classroom and how those interventions can be easily implemented.

The findings from this study may reflect the highly publicized and accepted notion that ADHD is commonly treated through the use of psychostimulant interventions (DuPaul, 2007), and the lack of evidence for long-term academic gains in children and adolescents with ADHD (Frankenberger & Cannon, 1999; Weber et al., 1992). However, educational interventions have been noted to have the greatest effect when it comes to enhancing academic gains for students diagnosed with ADHD (Purdie et al., 2002). As such, it is important that teachers know how to implement these strategies so they can help students with ADHD succeed academically (Barry & Messer, 2003).

On the other hand, it is imperative scientific data is presented objectively to the public so there is not confusion (Millar & Wynne, 1988). Teachers, as well as the public, should be aware of the uncertainty in ADHD research. For instance, according to the National Institute of Health's (NIH) initial draft in 1998 "there were no data to indicate that ADHD is due to brain malfunction." However, this quote was later altered for the final report, "further research is still necessary to firmly establish ADHD as a brain disorder." The NIH Consensus Statement stated that they are uncertain whether ADHD is a disorder or whether it is derived from "taking a percentage of the normal population who have the most evidence of inattention and continuous activity and labeling them as having a disease" (NIH Consensus Report, 1998).

On a positive note, teachers surveyed disagreed with the statement, "Improving behavior (impulsivity, hyperactivity, and inattention) of ADHD students improves their emotional well-being and school-based achievement," and tended to disagree that "Once a student's pathological learning behaviors such as impulsivity, inattention and hyperactivity are decreased, his/her general cognitive abilities will improve as well." These results are positive because there is no scientific evidence supporting either of these statements (Purdie et al., 2002). Medication can have a positive effect on attention and concentration, as well as impulsivity and hyperactivity; however, medication is only one piece of the puzzle. Educational interventions are critical in helping children succeed academically in the classroom.

Interestingly, findings indicate that reading peer-reviewed articles was not significantly related to teachers' knowledge about ADHD; however, teachers' knowledge about the scientific process was significantly related to their ADHD knowledge. These findings suggest teachers may not be reading empirical articles regarding ADHD. Alternatively, it could be that teachers who understand the scientific process are better at discerning between empirical claims regarding ADHD rather than unconfirmed claims. Based on these research findings, teachers were not asked to specify what kind of journals or articles they were reading. As such, it was not possible to know if they were reading, peer-reviewed, first-tier journal articles regarding ADHD or some other articles they believed were reliable and valid. Further research is needed to eliminate these possible confounds.

Implications for Training

Teachers of pre-K-12 students should be taught how to become critical consumers of research. This can be accomplished by offering course requirements in college and mandatory continuing education courses. Researching, reading, and discussing the information in professional journal articles should also be incorporated into a teacher's everyday schedule, allowing the time needed to stay abreast of current issues. One suggestion that may make this more feasible is to have the school psychologist coordinate and facilitate a research club where teachers are teamed together and assigned certain topics and articles. The team of teachers could read and discuss the research they have been assigned, and then they can disseminate the information to their colleagues, thus reducing the workload on each teacher. This process would actively involve teachers in becoming scientifically literate, which would encourage critical thinking among the teachers and eventually lead to implementing scientifically-based classroom interventions. In addition, school psychologists could be involved in ensuring in-service trainings are based on valid, empirically-based information that can be easily translated into classroom practice.

Limitations and Directions for Future Research

There were several limitations in this study. For instance, the low sample size ($N = 115$; 29%) and response rate could have affected the results stemming from sampling biases. In addition all participants were from Wisconsin, therefore affecting the extent to which the current findings can be generalized. Despite this possible limitation, a survey conducted nationwide of teachers of students with disabilities indicated there were no significant differences between Wisconsin responses and those of other states (Snider, Frankenberger, & Aspenson, 2000).

Further, this literature review revealed that the majority of the research regarding ADHD presented to the public supports ADHD as a neurological disorder, including the NIMH. As a result, it may be unfair to expect teachers to spend an inordinate amount of time sorting through extensive studies pertaining to ADHD as well as other disabilities they encounter, especially since most teachers are overworked and are modestly paid. Teachers, as well as the rest of society, should be able to place a certain level of confidence in our government (e.g., NIMH) to compile objective findings related to pertinent health issues and present uncertainty when applicable, so we can readily find what the latest scientific findings suggest for effective interventions.

Future research should involve examining the educational background requirements of teachers. For instance, it would be helpful to look at the teaching degree course requirements and also determine if a bachelor's degree differs from a master's degree with regard to research-based courses. For example, undergraduate psychology majors or minors are required to take two core courses in research methods. In addition, the importance of relying on scientific evidence and practicing research methods is strongly emphasized throughout psychology courses. Further, the reliance on empirical evidence and the use of the scientific method is repeatedly emphasized in all of the school psychology graduate courses, as well. This may be something to incorporate within teacher-education programs.

It is also imperative that we emphasize the importance that teachers stay abreast of current research through journal articles or other scientific-based literature. This is especially important because of the crucial role they play in children's lives. Once teachers realize the importance of being consumers of scientifically-based literature, they may be more willing to "understand" the science behind learning disabilities. Further, implementing research-based in-service training throughout the education system may be beneficial. Currently teachers are required to take continuing education classes every few years. It would behoove teachers to take classes as part of their continuing education based on current research-related issues as well as requiring teachers to do research papers in these courses. Schools could also provide opportunities for teachers to read and discuss current research. This may help teachers become more familiar in their everyday setting with empirical data. Having relevant journals or journal articles available in the teachers' lounge as well as conducting weekly group discussions about the articles could familiarize them with empirical data. These suggestions may help teachers to think critically and analytically regarding learning disabilities, which will enable teachers to recommend a scientifically valid intervention for our children.

Summary

Teachers play a very important role in the diagnosis of ADHD as well as numerous other disabilities, so it is crucial that teachers are knowledgeable and objective when it comes to making classroom decisions for children and adolescents who are suspected of, or diagnosed with, ADHD. Teachers were found to be the professionals who most often recommended the initial assessment of ADHD (Carney & Gerken, 2007; Cornell-Swanson et al. 2005, Frankenberger et al. 2001; Snider et al., 2003). In addition, pharmacological interventions were reported as being the intervention used most often with children and adolescents diagnosed with ADHD, and many times it is the only intervention offered to these children and adolescents at home and school, despite the lack of evidence about academic gains (Alto & Frankenberger, 1995, DuPaul, 2007, Frankenberger et al., 2001; Purdie, Hattie, & Carroll, 2002; Snider et al, 2003; Weber, Frankenberger, & Heilman, 1992). There is currently an abundance of information available on the suspected causes related to a biological basis of ADHD; however, more certainty is presented than should be regarding this research, indicating a false security to many that medication only is the intervention of choice. It is important that teachers become critical consumers of the research to better aide in professional decision-making and realize the importance of effective educational interventions they should be implementing.

The results of this study provide evidence for the current state of teachers' confusion about the causes, correlates, and interventions for ADHD. In addition, the findings indicate teachers in Wisconsin may have limited access to, and limited experience with, the empirical research on important disabilities, such as ADHD. The teachers who responded to this survey had less knowledge than one would expect regarding the scientific process and ADHD considering the pivotal role they play in diagnosing ADHD among students. These results are similar to those found by Frankenberger et al. (2001) who surveyed school psychologists, and Snider et al. (2003) who surveyed teachers' knowledge of ADHD and stimulants. Given the low number of respondents who said they have free access to journals, schools should look into making sure their staff has not only free access to journal articles but are given time to read the articles, as well. These results show that it is not the years of teaching experience or degree attained (bachelor's versus master's) that relates to their understanding of the scientific process and ability to discern between unsound methods and uncertainty presented in research, but rather the content presented in trainings, and how the content can be put into practical classroom practice. As a result, training efforts should be made to help teachers become consumers of scientific knowledge.

This study determined whether a clearer understanding of the scientific process makes a difference in the degree to which teachers are able to read, understand, and appropriately apply research on ADHD when working with students in the classroom. Participants consisted of 115 teachers from Wisconsin and were given a survey based on knowledge, opinions, and experiences. Results indicated 72% of the teachers surveyed were classified as having an "understanding of the scientific process" (according to NSF 2002 standards). There was no difference between teachers who attained their master's degree or higher versus teachers who attained their bachelor's degree with regard to their scientific understanding. Results also showed teachers' knowledge about the scientific process was significantly related to their ADHD knowledge.

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Table 1

Demographics of Participants

	n	%
Gender		
Males	20	17
Females	94	82
Highest Degree Held		
Bachelor's	37	32
Master's	77	67
Grades Taught		
Elementary	35	30
Junior High	29	25
High School	50	44
Class Taught		
General Education	46	40
Special Education	62	54
Both	3	3

Note: One respondent did not identify gender, highest degree held, grades taught, and three respondents did not identify class taught

Table 2

Means and Standard Deviations for Teachers' Level of Scientific Knowledge

Statement	***M***	***SD***	**% Agreement**
A1) By the time scientific studies finally reach the media, we can *not* safely assume the information is true.	3.80*	.81	69.6%
A2) Scientific research *does not* get rid of the uncertainty in science.	2.68	.95	24.4%
A3) Science is *not* the generator of certainty when it is properly conducted.	3.00	.91	33.1%
A4) Uncertainties and ambiguities are *not* the result of incompetent scientists.	2.14*	.83	4.4%

Note. * *not* a neutral response
4.00-5.00 = agree
3.50-3.99 = tendency to agree
2.50-3.49 = neutral
2.49-2.01 = tendency to disagree
2.00 or below = disagree

Table 3

Means and Standard Deviations for Teachers' Level of ADHD Knowledge

Statement	*M*	*SD*	% Agreement
B1) Inattention or inappropriate behaviors may be explained by factors other than ADHD. For example, behaviors may be maintained by the need to obtain something (e.g., attention from peers or teacher) or to avoid something (e.g., school tasks).	4.52*	.75	94.7%
B2) There are *not* convincing and reliable data to indicate that ADHD is caused by a brain malfunction.	3.26	.89	36.5%
B3) Diagnosis of ADHD can *not* be confirmed if stimulant medication improves his/her attention.	3.07	.98	36.5%
B4) Once a student's pathological learning behaviors such as impulsivity, inattention, and hyperactivity are decreased, his/her general cognitive abilities will *not* improve as well.	3.55*	1.02	65.2%
B5) Medicated ADHD children are *not* more likely to attend universities than non-medicated ADHD children.	3.08	.89	27.9%
B6) Medicated ADHD children are not less likely to become delinquent than their non-medicated ADHD peers.	3.07	.85	36.5%
B7) Educational interventions (i.e., sitting the ADHD child in front of the room, providing frequent breaks between educational tasks, structuring the classroom more formally than informally, implementing behavioral principles) have been found to be more effective than pharmacological interventions with regard to cognitive outcomes of in-class academic achievement (e.g., math and language tasks).	3.05	.85	28.6%
B8) Improving behavior (impulsivity, hyperactivity, and inattention) of ADHD students improves their emotional well-being and school-based achievement.	4.16*	.80	89.5%

Note. * *not* a neutral response
4.00-5.00 = agree
3.50-3.99 = tendency to agree
2.50-3.49 = neutral
2.49-2.01 = tendency to disagree
2.00 or below = disagree

Table 4

Means and Standard Deviations for Teachers' Opinions Statements Regarding ADHD

Statement	*M*	*SD*	% Agreement
C1) ADHD can be reliably diagnosed via collecting behavioral data in the classroom (e.g., time sampling, interval recording).	3.05	.97	35.6%
C2) A behavioral assessment followed by reasonable interventions (i.e., token economy, time-out, peer tutoring, positive reinforcement) should be sufficient to address many classroom behaviors without a referral for ADHD.	3.20	1.05	41.7%
C3) I usually ask the student with ADHD to evaluate his/her own performance after finishing school tasks. I also give feedback regarding specific criteria of this evaluation.	3.15	.94	43.4%
C4) I encourage/praise a hyperactive student frequently and immediately. He/she needs more positive remarks than other students in order to have a good performance.	3.50*	1.00	60%
C5) Medical interventions (i.e., prescription drugs) are more scientifically valid than non-medical interventions (i.e., educational; see #11 for description) when it comes to dealing with ADHD children.	2.67	.90	17.4%

Note. * *not* a neutral response
4.00-5.00 = agree
3.50-3.99 = tendency to agree
2.50-3.49 = neutral
2.49-2.01 = tendency to disagree
2.00 or below = disagree

Appendix A

Consent to Participate In UW-Stout Approved Research

Title: Teachers' Understanding of Science and ADHD

Investigator: Wendy Stuttgen
715-839-7956
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Research Sponsor: Crystal Cullerton-Sen
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Dear Teachers:

I am a University of Wisconsin-Stout School Psychology graduate student conducting research to determine if teachers can be better served to help manage behavioral/psychological problems in our students (e.g., Attention Deficit Hyperactivity Disorder [ADHD]). I am conducting this study as a requirement for my Education Specialist Degree at the University Wisconsin-Stout. Dr. Crystal Cullerton-Sen, assistant professor in the School Psychology Program, is my advisor. I feel this is an important topic to study because the number of children being diagnosed with ADHD is on the rise in the United States, and research indicates that teachers, as opposed to other educational professions, most often recommend the initial assessment of ADHD. I am interested in learning more about teachers' knowledge, opinions, training, and experiences working with children with ADHD, as well as their understanding of the scientific process. Your participation in this study will help answer many questions related to this topic, which is why I am asking for your time to participate in this research project. The only possible risk to the participants may be feelings of frustration related to dealing with children with ADHD in the classroom. There are no direct benefits to the participants in this study; however, such information may help educators better meet the needs of teachers who may be challenged by working with students with behavior problems, specifically those with ADHD.

I am asking you to complete a brief questionnaire, which may take no longer than 10-20 minutes to complete. After completing the questionnaire, please return it in the envelope marked with my address.

Your name was randomly selected through the Department of Public Instruction. Your participation is completely voluntary. However, should you choose not to participate and later wish to withdraw from the study, there is no way to identify your anonymous document after it has been turned into the investigator. Your decision whether or not to participate will not affect your future relations with the University of Wisconsin Stout; however, your participation is greatly appreciated. Your participation will remain anonymous; therefore, your answers will not be linked to your identity. In addition, the name and area of your school will remain anonymous. In order to remain anonymous, it is crucial not to include your name and/or school on any of the materials. By completing the following survey, you agree to participate in the project entitled: "Teachers' Understanding of Science and ADHD."

This study has been reviewed and approved by The University of Wisconsin-Stout's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study please contact the Investigator or Advisor. If you have any questions, concerns, or reports regarding your rights as a research subject, please contact the IRB Administrator. Thank you for your participation and inquiries will be kept confidential.

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Appendix B

For each of the following statements regarding ADHD, please indicate **how strongly you agree or disagree.**

1	2	3	4	5
strongly disagree	**disagree**	**neutral**	**agree**	**strongly agree**

1) Inattention or inappropriate behaviors may be explained by factors other than ADHD. For example, behaviors may be maintained by the need to obtain something (e.g., attention from peers or teacher) or to avoid something (e.g., school tasks). 1 2 3 4 5

2) There are convincing and reliable data to indicate that ADHD is caused by a brain malfunction. 1 2 3 4 5

3) ADHD can be reliably diagnosed via collecting behavioral data in the classroom (e.g., time sampling, interval recording). 1 2 3 4 5

4) Diagnosis of ADHD can be confirmed if stimulant medication improves his/her attention. 1 2 3 4 5

5) A behavioral assessment followed by reasonable interventions (i.e., token economy, time-out, peer tutoring, positive reinforcement) should be sufficient to address many classroom behaviors without a referral for ADHD. 1 2 3 4 5

6) Once a student's pathological learning behaviors such as impulsivity, inattention, and hyperactivity are decreased, his/her general cognitive abilities will improve as well. 1 2 3 4 5

7) Medicated ADHD children are more likely to attend universities than non-medicated ADHD children. 1 2 3 4 5

8) Medicated ADHD children are less likely to become delinquent than their non-medicated ADHD peers. 1 2 3 4 5

9) I usually ask the student with ADHD to evaluate his/her own performance after finishing school tasks. I also give feedback regarding specific criteria of this evaluation. 1 2 3 4 5

10) I encourage/praise a hyperactive student frequently and immediately. He/she needs more positive remarks than other students in order to have a good performance. 1 2 3 4 5

11) Educational interventions (i.e., sitting the ADHD child in front of the room, providing frequent breaks between educational tasks, structuring the classroom more formally than informally, implementing behavioral principles) have been found to be more effective than pharmacological interventions with regard to cognitive outcomes of in-class academic achievement (e.g., math and language tasks). 1 2 3 4 5

12) Improving behavior (impulsivity, hyperactivity, and inattention) of ADHD students 1 2 3 4 5

improves their emotional well-being and school-based achievement.

13) Medical interventions (i.e., prescription drugs) are more scientifically valid than non-medical interventions (i.e., educational; see #11 for description) when it comes to dealing with children with ADHD.	1	2	3	4	5
14) I feel that I receive adequate training for recognizing and responding to ADHD disorders.	1	2	3	4	5
15) I am skeptical of the media's (i.e., TV news) portrayal of scientific issues (i.e., ADHD), so I read peer-reviewed journal articles frequently.	1	2	3	4	5
16) By the time scientific studies finally reach the media, we can safely assume the information is true.	1	2	3	4	5
17) After reading three or four recent articles from *Time, Newsweek, New York Times,* etc. relating to ADHD, these articles give me a basic understanding of the scientific evidence surrounding ADHD.	1	2	3	4	5
18) Because there is so much conflicting information regarding ADHD, I am not sure what to believe anymore, so I rely on the advice of the doctors.	1	2	3	4	5
19) Scientific research gets rid of the uncertainty in science.	1	2	3	4	5
20) Science is the generator of certainty when it is properly conducted.	1	2	3	4	5
21) Uncertainties and ambiguities are the result of incompetent scientists.	1	2	3	4	5

22) Who provides the majority of the funding for research on prescription drugs (i.e., Ritalin, Adderall, etc.)?

____

23) "When you read news stories, you see certain sets of words and terms. We are interested in how many people recognize certain kinds of terms, and I would like to ask you a few brief questions in that regard. First, some articles refer to the results of a scientific study. When you read or hear the term scientific study, do you have a (please circle one of the responses below)

clear understanding of what it means

a general sense of what it means,

or little understanding of what it means?"

23a) If the response is "clear understanding" or "general sense": "In your own words, could you tell me what it means to study something scientifically?"____________________________

____
____
____
____
____
____

24) "Now, please think of this situation. Two scientists want to know if a certain drug is effective in treating high blood pressure. The first scientist wants to give the drug to 1,000 people with high blood pressure and see how many experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug?____

24a) Why is it better to test the drug this way?"______________________________________

____

____

____

25) "Now think about this situation. A doctor tells a couple that their 'genetic makeup' means that they've got one in four chances of having a child with an inherited illness.

Does this mean that if their first three children are healthy, the fourth will have the illness? *YES* *NO*

Does this mean that if their first child has the illness, the next three will not? *YES* *NO*

Does this mean that each of the couple's children will have the same risk of suffering from the illness? *YES* *NO*

Does this mean that if they have only three children, none will have the illness? *YES* *NO*

26) How many times have you attended an ADHD training regarding behavioral assessment and specialized interventions within the last 5 years? (Please circle one.)

ZERO *ONE* *TWO* *THREE* *FOUR* *FIVE* *SIX OR MORE*

27) How often do you read peer-reviewed journal articles?

NEVER *ONCE A WEEK* *ONCE A MONTH* *TWICE A YEAR* *ONCE A YEAR*

28) How often do you search a research database when searching for information (i.e., EBSCO Host)?

NEVER *ONCE A WEEK* *ONCE A MONTH* *TWICE A YEAR* *ONCE A YEAR*

29) Are you provided with free access to peer-reviewed journals? *YES* *NO* *DON'T KNOW*

30) Please circle what grades you teach: *ELEMENTARY* *JUNIOR HIGH* *HIGH SCHOOL*

31) Please circle your gender: *MALE* *FEMALE*

32) How many years have you been a teacher (please write in your answer) _______________.

33) Please circle which kind of class you teach: *GENERAL ED* *SPECIAL ED*

34) Please circle highest educational degree: *BACHELOR* *MASTER* *OTHER*__________