International Journal of Education Sciences (IJES)
Received on 05. 08. 2014/27. 08. 2014
REF. NO. IJES-508
(Always refer our Reference No. for all correspondence)
The Achievement Goal Orientation of Mathematics Students Suffering from Attention Deficit Hyperactivity Disorder
E. D. Spangenberg
University of Johannesburg, Department of Science and Technology Education (SciTechEd), Faculty of Education, University of Johannesburg, PO Box 524, Auckland Park, South Africa, 2006
Telephone: +27 82 441 7290, Fax: +27 11 559 4820, E-mail: ericas@uj.ac.za

The Achievement Goal Orientation of Mathematics Students Suffering from Attention Deficit Hyperactivity Disorder

E. D. Spangenberg*

University of Johannesburg, Department of Science and Technology Education (SciTechEd), Faculty of Education, University of Johannesburg, PO Box 524, Auckland Park, South Africa, 2006
Telephone: +27 82 441 7290, Fax: +27 11 559 4820, E-mail: ericas@uj.ac.za

**Address for Correspondence:*

KEYWORDS Achievement goal orientation; mathematics; ADHD; motivation

ABSTRACT This research reports on the achievement goal orientation of eighth- and ninth-grade mathematics students suffering from attention deficit hyperactivity disorder (ADHD) in the Ekurhuleni-East District in South Africa. The research questions were as follows: (1) What is the achievement goal orientation of mathematics students suffering from ADHD and those not suffering from ADHD and (2) What environmental factors affect student achievement goal orientation in mathematics learning? A social constructivist paradigm was adopted, using both qualitative and quantitative methods. Ten eighth- and ninth-grade mathematics students suffering from ADHD and 10 eighth- and ninth-grade mathematics students not suffering from ADHD completed structured questionnaires, and one mathematics student suffering from ADHD participated in a one-to-one interview. The results revealed that non-ADHD mathematics students regarded their goal orientation as being significantly higher than that of ADHD mathematics students. Their goal orientation pertained to their perception of peers' mastery goal orientation, and behavioral and cognitive engagement. ADHD mathematics students regarded their goal orientation as being significantly higher than that of non-ADHD mathematics students pertaining to their personal

performance-avoid goal orientation, perception of parents' mastery emphasis and their perception of parents' performance emphasis. The article adds to research on the achievement goal orientation of mathematics students suffering from attention deficit hyperactivity disorder in South Africa.

INTRODUCTION AND BACKGROUND

The purpose of this paper is to identify the achievement goal orientation of eighth- and ninth-grade mathematics students suffering from attention deficit hyperactivity disorder (ADHD) in relationship to those mathematics students not suffering from ADHD and the environmental factors affecting ADHD students' motivation in mathematics in a school in Ekurhuleni-East. Achievement goal orientation is based on a modern "goal-as-motives" theory suggesting "all actions are given meaning, direction and purpose by the goals that individuals seek out, and that the quality and intensity of behavior will change as these goals change" (Covington 2000:174). By reinforcing particular goals and disregarding others, a teacher can influence and ultimately change the way in which students learn, and thus change their motivation (Covington 2000), which could lead to better performance in mathematics.

Goal orientation is one of the key determinants influencing the achievement patterns of students (Ames 1990). Specifically, goal orientation refers to "a person's set of beliefs that reflect the reasons why they approach and engage in academic and learning tasks" (McGrew 2008:1). In relation to goal orientation, there is a difference between performance goal orientation and learning or mastering goal orientation. Whereas performance goal orientated persons are primarily concerned with their personal abilities within society, in comparison to others, learning goal orientated people focus on the understanding and completion of tasks, learning and mastering of new skills and problem solving (McGrew 2008).

Schweitzer, Cummins, Carole and Kant (2001:1) define ADHD as a problem with inattentiveness, over-activity, "excessive motor hyperactivity or restlessness, and poor impulse control", starting at a very early age. In addition, ADHD students have difficulty with cognitive skills or executive functions (EF). According to Barkley (2009:41), executive functioning (EF) are "actions we perform to ourselves and direct at ourselves so as to accomplish self-control, goal-oriented behavior and maximization of future outcomes". Thus, milestones, such as tying shoes, knowing the difference between left and right, and even walking, can be difficult for ADHD students.

Students' goals influence their learning activities, engagement in tasks, attitude towards learning, and consequently their achievement. According to Vedder-Weiss and Fortus (2011:200), the adoption of different goal orientations leads to differences in the way students engage with school work and their consequent emotional experiences at school. In addition, McGrew (2008:1) argues achievement goal orientation has vital implications for education because it is believed "by differentially reinforcing some goals (and not others), teachers can influence (change) the reasons why students learn – that is change their motivation".

Much research (e.g. Ackerman, Dyckman 1983; Lamminmaeki, Ahonen, Naerhi, Lyytinem, Todd de Barra 1995; Marshall, Hynd, Handwerk, Hall 1997; Zentall 1990; Zentall, Ferkis 1993; Zentall, Smith, Lee, Wieczorek 1994) has been dedicated towards the negative impact of ADHD on school performance. Furthermore, most research on academic success and ADHD has focused on reading disorders in children with ADHD rather than difficulties in mathematics (Lucangeli, Cabrele 2006). August and Garfinkel (1990) examined the reading ability of ADHD boys, diagnosed at a university outpatient clinic, against the reading ability of non-ADHD boys. Barry, Lyman and Klinger (2002:274) focused on the negative consequences ADHD has on an individual's academic achievements due to behavior, and argued:

"children with ADHD experience shortfalls in some of the abilities establishing the executive functions such as planning, organizing, maintaining an appropriate problem-solving set to achieve a future goal, inhibiting an inappropriate response or deferring a response to a more appropriate time representing a task mentally (i.e. in working memory), cognitive flexibility and deduction based on limited information".

However, it is not clear whether behavioral or cognitive deficiencies associated with ADHD disorder influence achievement goal orientation. Moreover, there is little evidence of research which explores the influence of ADHD on performance, specifically in the fields of problem solving and calculation, and goal achievement orientation, especially with regard to particular symptoms associated with ADHD and subtypes of ADHD, such as hyperactivity and inattention.

A study identifying the achievement goal orientation of eighth- and ninth-grade mathematics students suffering from ADHD in relationship to those mathematics students not suffering from ADHD and determining the environmental factors affecting student motivation in mathematics is new to South Africa, even though there have been investigations into the types of goals students assume in the classroom and the contextual factors which play a role in students' choices of goals and learning activities (Tapola, Niemivirta 2008; Vedder-Weiss,

Fortus 2011). Greven, Harlaar, Dale and Plomin (2011:6) conducted a study on twin pairs in the United Kingdom and found that the "genetic overlap between ADHD and reading is largely driven by inattentiveness rather than hyperactivity-impulsivity". Also, Willcut, Pennington, Olson and DeFries (2007) argue that reading difficulties and ADHD symptoms are highly heritable. Alloway, Gathercole, Holmes, Place, Elliott and Hilton (2009) found that both learners with ADHD and those with working memory deficits exhibit behavioral problems in the classroom. According to Cockcroft (2011) ADHD learners perform significantly poorer than others in all aspects of working memory. However, their storage abilities are stronger than their processing abilities. On contrary, verbal and visual-spatial abilities were equally developed for all groups. Amod, Vorster and Lazarus (2013) focus on perceptions of South African Foundation Phase teachers regarding ADHD and found a lack of knowledge and misperceptions pertaining to ADHD.

Rakoczy, Harks, Klieme, Blumb and Hochweber (2013) reveal that feedback in mathematics in terms of perceived competence support and usefulness indirectly effects the development of interest and mastery approach goal orientation. In particular, Vedder-Weiss and Fortus (2011) refer to a wide range of motivation research and conclude declining in motivation and attitude toward learning have been common across learning areas and are often linked to changes in classroom environment.

Consequently, the research questions arising from this initial literature review, as discussed above, were: (1) What is the achievement goal orientation of mathematics students suffering from ADHD and those not suffering from ADHD; and (2) what environmental factors affect student motivation goal orientation in mathematics learning? Hence, an in-depth literature inquiry with regard to achievement goal orientation of mathematics students with ADHD pertaining to environmental factors was conducted, as discussed below.

Achievement goal orientation of students with ADHD pertaining to environmental factors

There exist a number of environmental factors playing a role in developing students' achievement goal orientations. According to Anderman and Midgley (1997) students' perceptions and beliefs of classroom environment and ability level lead to changes in motivation and subsequently lead to changes in achievement. Also, Furner and Gonzalez-DeHass (2011) confirmed classroom practices can shape the goals students take on. Furthermore, Yates (1997), Tapola and Niemivirta (2008), and Vedder-Weiss and Fortus

(2011) concluded motivation toward learning and goal orientation are linked to changes in classroom environment.

Vedder-Weiss and Fortus (2011:200) comment the adoption of different goal orientations lead to differences in the way students engage with school work and their consequent emotional experiences at school. In particular, they refer to a number of key motivation constructs, which contribute to the development of mastery orientated, performance approach, or performance-avoidance goals in learners. When "pursuing performance-approach goals, the student is focused on attaining favorable judgments of competence, whereas when pursuing performance-avoidance goals the student is focused on avoiding unfavorable judgments of competence" (Vedder-Weiss, Fortus 2011:201). According to Vedder-Weiss and Fortus (2011), these constructs, which are all indicators of students' motivation, include students' perceptions of their personal and peers' goal orientation, the classroom environment and school culture, their cognitive and behavior engagements, including self-efficiency, in the classroom, their engagement in extra-curricular activities and parental and teachers' influences or emphases in terms of performance goal orientation and mastering goal orientation.

DuPaul, Volpe, Jitendra, Lutz, Lorah and Gruber (2004) examined different factors, including behavioral observations determining academic achievement in ADHD students. In particular, the strongest factor for academic achievement found was teachers' perceptions of academic skills. Thus, interventions should include the use of medication and be combined with academic support.

According to Zentall (1990) Intelligence Quota (IQ) and reading comprehension skills showed no indications concerning ADHD students' mathematical skills. However, calculation speed and task behavior had significant importance pertaining to their performance and goal achievement. On the contrary, Lamminmaeki et al. (1995) found students with ADHD were no more impaired in mathematics than those without ADHD. Furthermore, Zentall et al. (1994) discovered the ADHD boys all showed a lower problem-solving ability. The poor performance and achievement goal orientation was accredited to the various subtypes of ADHD found typically as a behavioral symptom: distractibility, hyperactivity, and impulsivity. Zentall et al. (1994) believed when an ADHD child is distracted, the child is attempting to lessen his or her under-stimulated mind by seeking tasks or reactions increasing the levels of stimulation. Thus, by using external stimulating factors during a boring but routine task, the child with ADHD will perform better.

Given the limited information and research on mathematical understanding and calculations within ADHD students, very few conclusions can be made. However, it has been shown children with ADHD are slower and less accurate when conducting calculations than non-ADHD children. Thus, the conjecture is the over-working of memory causes the need to solve and calculate, which then causes the deficit in achievement goal orientation and performance. Moreover, the poor achievement goal orientations in calculations and problem solving in mathematics may be associated with hyperactivity and distractibility, two major indicators of ADHD.

There could be a relationship between the practice of the teacher and environmental factors affecting the motivation of students suffering from ADHD and their motivation in mathematics. Thus, the main focus of the study is to establish the motivation goal orientation of students suffering of ADHD and those not suffering from ADHD and secondly, to identify the factors affecting student motivation goal orientation in mathematics learning. From this research, one should be able to understand and improve student motivation, which could result in better performance in mathematics.

RESEARCH METHODOLOGY

Research design

Vandeyar (2010:87) noted social investigations are bound in the "consideration of how certain phenomena or forms of knowledge are achieved by people in action", which convinced me to adopt a social constructivism theoretical paradigm. Moreover, this paradigm can be tailored to an investigation of how students, parents and teachers perceive achievement goal orientation of the school and classroom environment, and the way in which these perceptions inform and shape their choice of a specific goal orientation.

I utilized both quantitative and qualitative methods in the study. In particular, Creswell and Plano Clark (2006:1) state "... that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone". Firstly, I established students' perceptions regarding achievement goal orientation quantitatively through questionnaires. In order to compare the achievement goal orientation of students suffering with ADHD and those not suffering from ADHD, the following hypothesis was interrogated in the quantitative approach:

There are significant differences between the achievement goal orientation of mathematics students suffering from ADHD and those mathematics students not suffering from ADHD.

Secondly, a qualitative technique was followed by interviewing a mathematics student suffering from ADHD to determine the environmental factors affecting an ADHD mathematics student's motivation in mathematics.

Sample

A purposeful sampling technique (Creswell 2003) was used to select eighth- and ninth-grade mathematics students suffering from ADHD and those not suffering from ADHD from one secondary school in a single district in South Africa, namely the Ekurhuleni-East District. Criterion sampling was utilized (Palys 2008). The area was chosen for easy access to the school and the participants were selected through postings in the school's weekly newsletter, private discussions with the school counsellor and parent evening discussions with the parents of those students suffering from ADHD. Participation was voluntary, consent was obtained and the anonymity of the participants was protected (Mouton 2001). From a population of 540 eighth- and ninth-grade students in the school, 10 non-ADHD students and 10 ADHD students participated voluntarily. Sixteen of the 20 students were in one class. Furthermore, all the students in the study were proficient in reading, speaking and writing in English. Moreover, I could only utilize a naturally formed group, namely students in a classroom setup, for this research which justifies convenience sampling (Creswell 2003). Participants in the ADHD sample were required to have a diagnosis of ADHD from a physician or psychologist, but no diagnosis of a neurological disorder or genetic syndrome, for example pervasive developmental disorders, psychotic disorders or Tourette's disorder. Also, the students without ADHD were required not to have any previous diagnosis of ADHD or any learning or behavior problems identified by parents. Seven of the students suffering from ADHD had been taking psycho-stimulant medication for their symptoms, for example Ritalin or Concerta. However, on the data-gathering date, participants were asked to be medication-free. Eight students suffering from ADHD were receiving some form of special education service, including support from an educational tutor. Only one student from the sample, suffering from ADHD, agreed to participate in the interview.

Data collection: questionnaires and an interview

The quantitative feature was a structured questionnaire based on an existing standardized instrument. Permission was obtained to utilize and adapt a questionnaire for mathematics, developed by Veder-Weiss and Fortus (2011) for a similar study in Israel comparing fifth- to eighth-grade students' goal orientations in science learning. The questionnaire consisted of 89 mixed-survey items with a 1–5 point Likert scale (1 = Not true at all and 5 = Very true) relating to 17 motivation constructs. The questionnaires were completed in test conditions,

and took approximately one hour. The reasons for using the questionnaire were, firstly, the questionnaire was standardized so it allowed minimal misinterpretation to occur concerning the information presented. This particular issue was solved by piloting the questions. The pilot group consisted of two individuals, who were not participating in the final research project. One individual was clinically diagnosed with ADHD and the second individual was non-ADHD. Secondly, using a questionnaire is a relatively quick way of collecting information.

The qualitative research involved a one-on-one semi-structured interview conducted with one mathematics student suffering from ADHD, who participated voluntarily. Even though stimulating, the discussion of the student's views did not represent a natural setting. It explored some of the environmental factors affecting ADHD students' motivation in mathematics.

Data analyses

The results for each question in the questionnaire were averaged, and calculations were done to categorize these into the 17 key motivation constructs, as discussed in the literature overview. The Mann-Whitney U-Test, as an appropriate non-parametric statistical technique, was undertaken to examine differences between the medians of the responses of non-ADHD mathematics students and ADHD mathematics students on the 17 key motivation constructs respectively. Table 1 presents data on the calculated *z*-values and the approximately calculated statistical significance of differences between the crossed variables. A correlation at the 0.05 level was assumed as significant.

Table 1: To be inserted here (pages 18-19)

I audio-recorded and transcribed the interview questions. Thereafter, I used open coding, a "heuristic exploratory problem-solving technique without specific formulas to follow" (Saldana 2009:8) to analyze the data from the one-on-one interview. Codes sharing the same characteristics were grouped into categories and grouped together to form themes (Saldana 2009). Table 2 represents the themes, categories and codes emerging from the qualitative analysis.

Table 2: To be inserted here (pages 20-21)

Reliability

The internal consistency of each of the of the 17 key motivation constructs was determined by using the Cronbach α coefficient as presented in Table 3. A score of 0.7 and higher was assumed to be reliable.

Table 3: To be inserted here (page 22)

However, due to the standardization of the instrument, no item was deleted and the constructs, as identified by Veder-Weiss and Fortus (2011) were calculated.

Validity

Veder-Weiss and Fortus (2011) granted permission for the amendment and usage of their questionnaire on goal orientations in science learning and its intellectual property rights are acknowledged. The questionnaire had already complied with all validity aspects. To ensure face and content validity, the questionnaire was shown to colleagues for comments and inputs, to ensure the constructs were clearly conceptualized. Consequently, the questionnaires were amended with regard to timeframes, terminology, readability and clarity. The purpose was to ensure coherency and consistency of the questions. The questionnaires were administered under examination conditions. All the participants' contributions, including literature, were recognized by proper referencing. The research questions, as outlined in the introduction of the study, were used as a framework for the design and development of the interview questions used in the study.

The discriminant validity of the data was assessed by exploratory factor analysis. Principal Components Analysis was used for factor extraction. Even though the Bartlett's test of sphericity was significant (p = .000 < .05), the Kaiser-Meyer-Olkin (KMO) measure was 0.302, which indicated the sampling was not adequate for factor analysis.

RESULTS

Findings from questionnaires

Non-ADHD mathematics students and ADHD mathematics students differed significantly at a 95% level in terms of five of the 17 motivation constructs mentioned by Veder-Weiss and Fortus (2011), namely students' personal performance-avoid goals orientation (p = .027 < .05); students' perception of peers' mastery goals orientation (p = .033 < .05); students' perception of parents' mastery emphasis (p = .011 < .05); students' perception of parents' performance emphasis (p = .005 < .05); and behavioral and cognitive engagement (p = .004 < .05).

As there were statistical significant differences between crossed variables, there was a need to analyze the data, indicating which continuous variable was higher on average as shown in Table 4.

Table 4: To be inserted here (page 23)

From this data, it can be concluded non-ADHD mathematics students regarded their goal orientation significantly higher than ADHD mathematics students, pertaining to:

students' perception of peers' mastery goals orientation (non-ADHD *Mdn* = 5 vs ADHD *Mdn* = 4), $U = 34.0$, $p = .033 < .05$ (at the 95% level of confidence), $r = .27$ (a finding with a low to moderate practical significance)

behavioral and cognitive engagement (non-ADHD *Mdn* = 5 vs ADHD *Mdn* = 4), $U = 12.5$, $p = .004 < .05$ (at the 95% level of confidence), $r = .03$ (a finding with a low practical significance).

In contrast, ADHD mathematics students regarded their goal orientation significantly higher than non-ADHD mathematics students, pertaining to:

students' personal performance-avoid goals orientation (non-ADHD *Mdn* = 3 vs ADHD *Mdn* = 4), $U = 21.0$, $p = .027 < .05$ (at the 95% level of confidence), $r = .49$ (a finding with moderate to high practical significance)

students' perception of parents' mastery emphasis (non-ADHD *Mdn* = 5 vs ADHD *Mdn* = 4), $U = 17.5$, $p = .011 < .05$ (at the 95% level of confidence), $r = .57$ (a finding with moderate to high practical significance)

students' perception of parents' performance emphasis (non-ADHD *Mdn* = 4, vs ADHD *Mdn* = 5), $U = 13.0$, $p = .005 < .05$ (at the 95% level of confidence), $r = .63$ (a finding with moderate to high practical significance).

The above-mentioned findings supported the hypothesis that there are significant differences in the achievement goal orientation of mathematics students suffering from ADHD and those mathematics students not suffering from ADHD.

Findings from the interview

In the following protocols, the name of the student is a pseudonym to protect his identity. The protocols are from an interview conducted on Friday 2 November 2012.

From the interview with a mathematics student suffering from ADHD to determine the environmental factors affecting an ADHD student's motivation in mathematics, it was found the student wants to achieve in mathematics, thus there is an emphasis on students' personal mastery goals orientation. Sammy stated "I actually [wants to] pass mathematics and finally Grade 8". Sammy noted he "actually understood the work, so [he] raised [his] hand and volunteered to answer one … [he] felt confident in [his] answer … , [he] knew that Term 4 just needs a little extra effort, so [he] decided to keep going", thus students' self-efficacy.

However ADHD affects his mathematical understanding, as he stated: “I have to keep motivated, even though that can be difficult with ADHD”.

The teacher, parents and peers play an important role in shaping this student’s achievement in mathematics, thus the student’s perception of the teacher's, parents’ and peers’ mastery goals. The teacher gives extra work, as the student noted: “After doing extra lessons on this work last week, I actually understood it. So I felt confident in my answer.” Furthermore, the teacher motivates the student to work: “Ma’am always encourages us to answer a sum regardless if we know it or not.” The student argues: “Not just with ma’am, but my mom also sends me to Kumon Maths every week”, and confesses he also gets “support from everyone” by “try[ing] to get my friends involved … It just makes it more fun knowing they’re there to help.” “I have a lot of support … [it] gives me confidence in my abilities.” Active extra-curricular engagement also has an influence on the student’s goal orientation as claimed: “Going to Kumon Maths every Wednesday afternoon, I started improving.” However, no evidence from the interview could be found on the student’s perceptions with regard to the teacher's performance-approach and avoid-goals emphasis, the school's mastery- and performance-goals emphasis, the student’s personal performance-approach or avoid-goals orientation, peers’ performance-approach or performance-avoid goals orientation, parents' mastery or performance emphasis, behavioral and cognitive engagement or active extra-curricular rejection.

It is important to note the above-mentioned findings were based on one ADHD student’s perceptions regarding achievement goal orientation, and should not be generalized to all students.

DISCUSSION

The paper focused on identifying the achievement goal orientation of eighth- and ninth-grade mathematics students suffering from attention deficit hyperactivity disorder (ADHD) in relationship to those mathematics students not suffering from ADHD and the environmental factors affecting ADHD mathematics students’ motivation in mathematics in a school in Ekurhuleni-East.

The results from the quantitative data address the first research question, namely non-ADHD mathematics students regarded their goal orientation as being significantly higher than that of ADHD mathematics students, pertaining to their perception of peers’ mastery goals orientation and behavioral and cognitive engagement. On the other hand, ADHD mathematics students regarded their goal orientation as being significantly higher than that of

non-ADHD mathematics students, pertaining to their personal performance-avoid goal orientation, perception of parents' mastery emphasis and their perception of parents' performance emphasis. Thus ADHD mathematics students, like the parents noted by Vedder-Weiss and Fortus (2013), perceive goals parents emphasize as better predictors of their motivation than perceptions of the goals peers emphasize.

However, from the qualitative interview, only a few environmental factors, which address the second research question, could be found affecting an ADHD mathematics student's motivation in mathematics. The ADHD mathematics student indicated he wanted to achieve in mathematics and his teacher, parents and peers play an important role in shaping his achievement in mathematics. Furthermore, extra-curricular engagement has an influence on his goal orientation. This aligns with the finding of Vedder-Weiss and Fortus (2012) that students' mastery goals orientation is a strong predictor of their extra-curricular engagement.

Even though the questionnaires on students' perceptions on the difference between non-ADHD mathematics students' and ADHD mathematics students' achievement goals suggest broad distinctions, these are not clearly mirrored in the interview with the ADHD mathematics student's responses. Limitations to the study were the sample was small and an interview was not conducted with non-ADHD mathematics students. This research was aimed at determining the achievement goal emphasis of ADHD and non-ADHD mathematics students at one particular school in a single district in a single province in South Africa. As a result, there is a low external validity, as the study conducted cannot be generalized to other situations. Another limitation is measures such as goal orientation versus classroom goal structures were not used within this specific sample. Rather than focusing on the difficulties students have in mathematics, most of the research on academic success and ADHD has focused on reading disorders.

CONCLUSION

In conclusion, mathematics students' achievement goal orientations can be taken into consideration when mathematics teachers plan learning activities and engage students in tasks. Such action on the part of teachers can ultimately influence students' attitudes towards learning and consequently their achievement. Tapola and Niemivirta (2008:291) acknowledge the necessity and importance of studying achievement goal orientation by arguing it improves our understanding of the relationship between the learning environment and student motivation, and therefore has practical implications for the way we structure our classrooms and learning environments and the instructional approaches we utilize. Moreover,

Lin, Hung, Lin, Lin and Lin (2009:553) suggest: "A focus on … how their orientation is related to their learning, could be a first step in showing our willingness to negotiate with our students and grant them autonomy."

RECOMMENDATIONS

Given the localized nature of this study, I recommend the results obtained be confirmed through similar studies of this nature and in other provinces in South Africa. In this way, a better understanding of the environmental factors affecting non-ADHD and ADHD mathematics students' motivation in mathematics can be obtained.

A recommendation is to identify goal orientation and perceptions of goals prompting by the classroom environment and unique to this specific sample, and then examine how achievement goals are related to academic success. An understanding of the goals of ADHD mathematics students will provide clues on how to improve academic success for these students and avoid high failure rates and drop-outs.

Further research is needed in areas of education concerning ADHD and mathematics understanding. The ways in which empirical realities manifest are much more complex than the motivation constructs pointed to in the literature in this paper. Hence, I suggest further research in this regard should be conducted.

Acknowledgements

I am grateful to the participants of the school and my honours students for their cooperation and inputs. I want to convey a special word of thanks to my colleagues at the University of Johannesburg for their professional assistance, guidance and support. The study was funded by the University of Johannesburg.

References

Ackerman PT, Dyckman RA, Oglesby DM 1983. Sex and group differences in reading and attention disordered children with and without hyperkinesis. *Journal of Learning Disabilities*, 16: 407–415.

Amod Z, Vorster A, Lazarus K 2013. Attention-Deficit/Hyperactivity Disorder (ADHD) as a barrier to learning and development within the South African Context: The perspective of

teachers. In: S Banerjee (Ed.): *Mental and behavioural disorders and diseases of the nervous system.* pp.215–241. doi: 10.5772/53784.

Alloway TC, Gathercole SE, Holmes J, Place M, Elliott JG, Hilton K 2009. The diagnostic utility of behavioral checklists in identifying children with ADHD and children with working memory deficits. *Child Psychiatry and Human Development*, 40(3): 353–366. doi: 10.1007/s10578-009-0131-3.

Ames C 1990. *Achievement goals and classroom structure: Developing a learning orientation*. Boston, MA: American Educational Research Association.

Anderman EM, Midgley C 1997. Changes in achievement goal orientations, perceived academic competence, and grades across the transition to middle-level schools. *Contemporary Educational Psychology*, 22: 269–298.

August GJ, Garfinkel BD 1990. Comorbidity of ADHD and reading disability among clinic referred children. *Journal of Abnormal Child Psychology,* 18 (1): 29–45.

Barkley RA 2009. Attention deficit hyperactivity disorder. In *The International Encyclopaedia of Depression*. In: RE Ingram (Ed.). New York, NY: Springer.

Barry TD, Lyman RD, Klinger LG 2002. Academic underachievement and attention deficit/hyperactivity disorder: The negative impact of symptom severity on school performance. *Journal of School Psychology,* 40: 259–283.

Cockcroft K 2011. Working memory functioning in children with attention-deficit/hyperactivity disorder (ADHD): A comparison between subtypes and normal controls, *Journal of Child and Adolescent Mental Health*, 23(2): 107–118. doi:10.2989/17280583.2011.634545.

Covington MV 2000. Goal theory, motivation and school achievement: An integrative review. *Annual Review of Psychology*, 51: 171–200.

Creswell JW 2003. *Research design: Qualitative, quantitative and mixed methods approaches.* 2nd edition. Thousand Oaks, CA: Sage.

Creswell JW, Plano Clark VL 2006. *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.

DuPaul GJ, Volpe RJ, Jitendra AK, Lutz JG, Lorah KS, Gruber R 2004. Elementary school students with AD/HD: Predictors of academic achievement. *Journal of School Psychology*, 42(4): 285–301.

Furner JM, Gonzalez-DeHass A 2011. How do students' mastery and performance goals relate to math anxiety? *Eurasia Journal of Mathematics, Science & Technology Education.* 7(4): 227–242.

Greven CU, Harlaar N, Dale PS, Plomin R 2011. Genetic overlap between ADHD symptoms and reading is largely driven by inattentiveness rather than hyperactivity-impulsivity. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, 20(1): 6–14. Available from: http://www.ncbi.nlm.nih.gov/pmc/journals/577.

Lamminmaeki T, Ahonen T, Naerhi V, Lyytinem H, Todd de Barra H 1995. Attention deficit hyperactivity disorder subtypes: Are there differences in academic problems? *Developmental Neuropsychology*, 11: 297–310.

Lin C, Hung P, Lin S, Lin B, Lin F 2009. The power of learning goal orientation in predicting student mathematics achievement. *International Journal of Science and Mathematics Education*, 7: 551–573.

Lucangeli D, Cabrele S 2006. Mathematical difficulties and ADHD. *Exceptionality*, 14(1): 53–62.

Marshall RM, Hynd GW, Handwerk MJ, Hall J 1997. Academic underachievement in ADHD subtypes. *Journal of Learning Disabilities*, 30: 635–642.

McGrew K 2008. Beyond IQ: A model of academic competence and motivation (MACM). Available from: http://www.iapsych.com/acmcewok/Achievementgoalorientation.html.

Mouton J 2001. *How to succeed in your master's & doctoral studies*. Pretoria: Van Schaik.

Palys T 2008. Purposive Sampling. In *The Sage Encyclopedia of Qualitative Research Methods* (Vol. 2:697–698). In: LM Given (Ed.). Thousand Oaks, CA: Sage.

Rakoczy K, Harks B, Klieme E, Blumb W, Hochweber J 2013. Written feedback in mathematics: Mediated by students' perception, moderated by goal orientation. *Learning and Instruction*, 27: 63–73. doi: 10.1016/j.learninstruc.2013.03.002.

Saldana J 2009. *The coding manual for qualitative researchers*. London: Sage.

Schweitzer JB, Cummins TK, Carole A, Kant CA 2001. Attention-deficit/hyperactivity disorder. *Medical Clinics of North America*, 85(3): 757–777.

Tapola A, Niemivirta M 2008. The role of achievement goal orientations in students' perceptions of and preferences for classroom environment. *British Journal of Psychology*, 78: 291–312.

Vandeyar T 2010. *The appearance of education policy on information and communication technology in South African Schools*. Ph. D. Thesis, Unpublished. Pretoria, South Africa: University of Pretoria,.

Vedder-Weiss D, Fortus D 2011. Adolescents' declining motivation to learn science: inevitable or not? *Journal of Research in Science Teaching*, 48(2): 199–216. doi: 10.1002/tea.20398.

Vedder-Weiss D, Fortus D 2012. Adolescents' declining motivation to learn science: A follow-up study. *Journal of Research in Science Teaching*, 49(2): 1057–1059. doi: 10.1002/tea.21049.

Vedder-Weiss D, Fortus D 2013. School, teacher, peers, and parents' goals emphases and adolescents' motivation to learn science in and out of school. *Journal of Research in Science Teaching*, 50(8): 952–988. doi: 10.1002/tea.21103.

Willcutt EG, Pennington BF, Olson RK, DeFries JC 2007. Understanding comorbidity: A twin study of reading disability and Attention-Deficit/Hyperactivity disorder. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, 144B(6): 709–714. doi: 10.1002/ajmg.b.30310.

Yates SM 1997. Goal orientation beliefs and mathematics achievement: A longitudinal study. *MERGA – Aotearoa*, 20: 599–607.

Zentall SS 1990. Fact-retrieval automatization and math problem-solving: Learning disabled, attention disordered and normal adolescents. *Journal of Educational Psychology*, 82: 856–865.

Zentall SS, Ferkis MA 1993. Mathematical problem solving for youth with ADHD, with and without learning disabilities. *Learning Disabilities Quarterly*, 16: 6–18.

Zentall SS, Smith, YN, Lee YB, Wieczorek C 1994. Mathematical outcomes of attention-deficit hyperactivity disorder. *Journal of Learning Disabilities*, 27: 510–519.

Table 1: Test statistics of non-ADHD mathematics students and ADHD mathematics students and the motivation constructs

Constructs	**Mann-Whitney U**	**Wilcoxon W**	***Z***	**Asymp. Sig. (2-tailed)**	**Exact Sig. (2-tailed)]**	**Exact Sig. (1-tailed)**
Students' perception of teacher's mastery goals emphasis	34.000	89.000	–1.218	0.223	0.247	0.124
Students' perception of teacher's performance-approach goals emphasis	30.500	85.500	–1.492	0.136	0.143	0.072
Students' perception of teacher's performance-avoid goals emphasis	46.000	101.000	–0.303	0.762	0.796	0.400
Students' perception of school's mastery goals emphasis	47.000	102.000	–0.229	0.819	0.853	0.427
Students' perception of school's performance goals emphasis	47.000	102.000	–0.229	0.819	0.853	0.427
Students' personal mastery goals orientation	32.500	87.500	–1.334	0.182	0.190	0.100
Students' personal performance-approach goals orientation	40.000	95.000	–0.760	0.447	0.481	0.24
Students' personal performance-avoid goals orientation	21.000	76.000	–2.209	0.027*	0.029*	0.015
Students' self-efficacy	43.500	98.500	–0.498	0.619	0.631	0.316

Table 1 continued on 19.

Table 1 continued from page 18.

Students' perception of peers' mastery goals orientation	22.500	77.500	–2.127	0.033*	0.035*	0.018
Students' perception of peers' performance-approach goals orientation	34.000	89.000	–1.220	0.222	0.247	0.124
Students' perception of peers' performance-avoid goals orientation	28.500	83.500	–1.645	0.100	0.105	0.053
Students' perception of parents' mastery emphasis	17.500	72.500	–2.533	0.011*	0.11*	0.056
Students' perception of parents' performance emphasis	13.000	68.000	–2.824	0.005*	0.004*	0.001
Behavioral and cognitive engagement	12.500	67.500	–2.866	0.004*	0.003*	0.001
Active extra-curricular engagement	48.500	103.500	–0.114	0.909	0.912	0.456
Active extra-curricular rejection	42.000	97.000	–0.607	0.544	0.579	0.290

*Correlation is significant at the 95% level

Table 2: Themes, categories and codes

Themes	Categories	Codes
Students want to gain understanding of mathematical concepts.	Wanting to be knowledgeable/ understand	To understand in greater detail Excited about finding out new information Confidence due to understanding the work Relief after finally passing term three
	Mathematics requires more work	Extra effort
ADHD affects mathematical understanding	Student cannot focus on a topic or the content for an extended period of time	Short attention span Impatient with progress
Students participate in extra-curricular mathematics-related activities	Involvement in mathematics activities outside school hours	Additional work outside school (extra-curricular activities): Kumon Maths Extra–curricular mathematics activities
	Understand the work	
Students want to achieve in mathematics and are concerned with getting the correct answers	Emphasis on achievement	Teacher encouragement: importance of completing questions
Parents play an important role in shaping students' achievement in mathematics	Involvement and support from the parents	Parents proud

Table 2 continued on 21.

Table 2 continued from page 20.

Students are motivated to learn mathematics because they want to achieve a set personal goal	Motivation to learn mathematics	Personal goals Unworthiness Ability to overcome the deficiency
Students compare their achievement with that of their peers, and this leads to feelings of doubt but can also lead to increased motivation	Motivated by peers' achievement and comparison of ability	Encouragement from peers Peer involvement Peer acceptance

Table 3: Internal reliability of the motivation constructs

Construct	**No. of items**	**Cronbach α**
Students' perception of teacher's mastery goals emphasis	8	0.683
Students' perception of teacher's performance-approach goals emphasis	4	0.746
Students' perception of teacher's performance-avoid goals emphasis	4	0.701
Students' perception of school's mastery goals emphasis	5	0.694
Students' perception of school's performance goals emphasis	5	0.722
Students' personal mastery goals orientation	7	0.715
Students' personal performance-approach goals orientation	5	0.675
Students' personal performance-avoid goals orientation	5	0.677
Students' self-efficacy	5	0.716
Students' perception of peers' mastery goals orientation	4	0.709
Students' perception of peers' performance-approach goals orientation	4	0.693
Students' perception of peers' performance-avoid goals orientation	4	0.678
Students' perception of parents' mastery emphasis	5	0.717
Students' perception of parents' performance emphasis	4	0.727
Behavioral and cognitive engagement	5	0.716
Active extra-curricular engagement	7	0.763
Active extra-curricular rejection	6	0.761

Table 4: Motivation constructs of non-ADHD mathematics students and ADHD mathematics students

Construct	**Independent variables**	***N***	**Mean rank**	**Sum of ranks**
Students' personal performance-avoid goals orientation	Non-ADHD	10	7.60	76.00
	ADHD	10	13.40	134.00
	ADHD	10	9.85	98.50
Students' perception of peers' mastery goals orientation	Non-ADHD	10	13.25	132.50
	ADHD	10	7.75	77.50
	ADHD	10	12.65	126.50
Students' perception of parents' mastery emphasis	Non-ADHD	10	13.75	137.50
	ADHD	10	7.25	72.50
Students' perception of parents' performance emphasis	Non-ADHD	10	6.80	68.00
	ADHD	10	14.20	142.00
Behavioral and cognitive engagement	Non-ADHD	10	14.25	142.50
	ADHD	10	6.75	67.50

From this data, it can be concluded non-ADHD mathematics students regarded their goal