



# Effect of Indirect Teacher Influence on Dependent-prone Students' Learning Outcomes in Secondary School Mathematics

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## Abstract

**Introduction.** Student's personality orientation and teacher's classroom behavior are among the many factors that influence student's learning. In this study, the author examined the effect of indirect teacher influence on dependent-prone students' learning outcomes (achievement) in mathematics at the senior secondary school level.

**Method.** The sample comprised 270 (117 boys and 153 girls) dependent-prone senior secondary school one students. Based on their scores in the dependent-proneness test the 270 dependent-prone students were identified from a pool of 587 students from twelve randomly selected senior secondary schools in Osun State, Nigeria. Their ages ranged between 15 and 17 years. Twelve intact classes were used. There were two treatment groups: Indirect Teacher Influence Group (Experimental Group) and Direct Teacher Influence Group (Control Group). The Modified Flanders' Interaction Category System was used to determine the extent to which the instructors in the two contrasting groups were able to exhibit the pattern of indirect influence and direct influence. The moderating effect of student's cognitive style preferences (Field Independence versus Field Dependence) on achievement in mathematics was also assessed. Data were analyzed by using Analysis of Covariance (ANCOVA).

**Results.** Results showed that dependent-prone students in indirect teacher influence group had higher achievement score in mathematics than their colleagues in the direct teacher influence group. The main effect of cognitive style was not statistically significant. However, the interaction effect of treatment and cognitive style preferences was statistically significant..

**Discussion and Conclusion.** The findings of this study point out that the dependent-prone students' learning outcomes in highly structured school subjects such as mathematics can be enhanced by giving them maximum opportunities to participate in the teaching and learning processes in the classroom. The effect of indirect teacher influence was stronger for dependent-prone students who were field dependents than for field independents.

A major implication of this study is that closer supervision through the use of direct influence in mathematics class may be harmful to dependent-prone students.

**Key words:** Teacher influence; Cognitive style; Dependent-proneness; Achievement in Mathematics.

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# **Incidencia de influencias directas e indirectas del profesor en los resultados de aprendizaje en Matemáticas de Secundaria en alumnos con tendencia a la dependencia**

## **Resumen**

**Introducción.** La orientación de la personalidad del estudiante y la conducta del profesor en el aula se encuentran entre los muchos factores que influyen en el aprendizaje de los estudiantes. En este estudio, el autor examina los efectos cruzados entre la influencia indirecta de los docentes con los estilos cognitivos de los estudiantes y el rendimiento en matemáticas, en el nivel de una escuela secundaria superior.

**Método.** La muestra fue de 270 (117 niños y 153 niñas), de estilo cognitivo dependiente, de escuela superior de tensión secundaria de un estudiantes. Sobre la base de sus puntuaciones en la prueba de propensión a la dependencia, los 270 estudiantes fueron identificados a partir de un grupo de 587 estudiantes de doce escuelas seleccionadas al azar secundaria superior en el estado de Osun (Nigeria). Sus edades oscilaban entre 15 y 17 años. Doce clases intactas fueron utilizadas. Había dos grupos de tratamiento: Grupo de Influencia Indirecta Maestro (grupo experimental) y la influencia directa de maestros de grupo (grupo control). El sistema de interacción de Flanders se utilizó para determinar el grado en que los instructores en los dos grupos contrastados fueron capaces de mostrar el patrón de influencia indirecta y directa. También fue evaluado el efecto modulador del estilo cognitivo (independientes de campo vs. dependientes de campo) en el rendimiento en matemáticas. Los datos fueron analizados utilizando análisis de covarianza (ANCOVA).

**Resultados.** Los resultados mostraron que los estudiantes dependientes, expuestos a la influencia indirecta del grupo de profesores tuvieron una mayor puntuación de rendimiento en matemáticas que sus colegas, los grupos de influencia directa. El principal efecto del estilo cognitivo no fue estadísticamente significativo. Sin embargo, un efecto de la interacción de las preferencias de estilo de tratamiento y el estilo cognitivo fue estadísticamente significativa.

**Discusión y Conclusión.** Los resultados de este estudio señalan que los resultados de los estudiantes dependientes, propensos a aprender en las materias escolares altamente estructuradas, tales como las matemáticas se puede mejorar al darles las máximas oportunidades para participar en los procesos de enseñanza-aprendizaje en el aula. El efecto de la influencia indirecta del maestro fue más fuerte para los estudiantes con propensión a la dependencia, que eran dependientes de campo, con respecto a los independientes de campo. Una de las implicaciones importantes de este estudio es que la supervisión más estrecha, a través del uso de la influencia directa en la clase de matemáticas, puede ser perjudicial para los estudiantes con estilo cognitivo independiente.

**Palabras clave:** influencia docente, estilo cognitivo, propensión a la dependencia; rendimiento en matemáticas.

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## **Introduction**

A typical classroom consists of students with different learning abilities and psychological orientation. Some are extroverts, some are introverts, and some have independent personality, while others are of dependent personality etcetera. More over, the patterns of how students think and process information are strikingly different. Some are field dependents, while some are field independents. Therefore, for effective teaching and learning of mathematics, there is the need for a mathematics teacher to identify each of these personality traits in his or her students and then apply the most appropriate teaching method.

Literature on students' personality, teacher's teaching style and learning (e.g. Felder, Felder, & Dietz, 2002; Milgram & Price, 2003; Ojo, 2003; Zhang, 2008) has shown that when students are classified by the use of test data into personality types they respond differently to highly versus loosely organized classroom activities and to lecturing versus group discussion. For example, Briggs and Briggs-Meyers (Felder, Felder, & Dietz, 2002) reported that students who were classified as extroverts on the Meyers-Briggs Type Indicator seem to learn better in learning environment that allow group work and interactive activities. On the other hand, according to Felder et al (2002) students who were classified as sensors like to work with concrete ideas, while students who were classified as judgers like planned and highly organized information. It therefore seems reasonable to expect that some students will need more concrete illustrations and explanations from the teacher than others, some will need more approval and reinforcement from the teacher than others, some will need minimal explanation from the teacher and while some may be able to understand the concepts being taught, even the first time the teacher presented the materials.

Educational and clinical psychologists (e.g. Amidon & Flanders, 1961; Bornstein & Kennedy, 1994; Bornstein & O'Neil, 2000; Bornstein, Riggs, Calabrese & Hills, 1996; Loas 2005; Lewin, 1935) have long observed that certain people have a strong inclination to look to others for support, guidance and reassurance, even in situations where they seem capable of initiating and completing tasks on their own. Such persons have traditionally been thought of having a dependent personality.

As the name implies, dependent personalities exhibit a pattern of dependent and submissive behavior, and also rely on others to make decisions for them. They fear rejection, need constant reassurance and advice, and are oversensitive to criticism or disapproval. They feel uncomfortable and helpless if they are alone and can be devastated when a close relationship ends. Typically lacking in self-confidence, the dependent personality rarely initiates projects or does things independently.

In academic setting, research findings (e.g. Adegoke, 2003, Bornstein & Kennedy, 1994) suggest that a dependent-prone student might become overly concerned with following the suggestions and directions of a teacher and more dependent on support and encouragement. In the classroom, acts of dependence occur when a student solicits for teacher direction more often than necessary. For example, a student who wants the teacher to approve of his or her work to ensure that it is satisfactory before going further is exhibiting dependent-prone personality.

Although different definitions of dependency as seen in clinical (e.g. Bornstein & O'Neil, 2000; Loas, et al, 2005; Loranger, 1996) and educational studies (e.g. Adegoke, 2003; Amidon & Flanders 1967; Bornstein & Kennedy, 1994) emphasized different aspects of the dependent person's functioning and interpersonal behavior, these definitions share common elements. Bornstein (1993) concluded that dependency is best conceptualized as consisting of four separate but related components. These components are:

- ✚ Motivational (i.e. a marked need for guidance, approval and support from others)
- ✚ Cognitive (i.e. a perception of the self as powerless and ineffectual along with the belief that others are powerful and in control of the outcomes of the situation)
- ✚ Affective (i.e. a tendency to become anxious and fearful when required to function independently, especially when the products of one's effort will be evaluated by others,
- ✚ Behavioral (i.e. a tendency to seek help, approval, guidance and reassurance from others)

Bornstein's (1993) discourse suggests that dependency is best understood as a personality orientation wherein cognitive, motivational, and affective tendencies interact to determine the behavior of the dependent person in various situations and settings.

In a classroom situation, a keen observer can identify three degrees of dependence (Adegoke, 2003; Amidon & Flanders, 1967). These are: high dependence; medium dependence; and low dependence. High dependence refers to a condition in which students voluntarily seek additional ways of complying with the authority of the teacher. This condition was aptly described by Lewin (1935, p.132) as “at every point within his or her (the pupil) sphere of action, he or she is internally controlled by the wishes of the adult (teacher)”. Medium dependence refers to the average classroom condition in which teacher direction is essential to initiate and guide activities but the pupils do not voluntarily solicit it. When it occurs they comply. Low dependence refers to a condition in which pupils react to teacher’s direction if they occur but their present activities usually teacher-directed can be carried on without teacher direction. In the face of difficulties, pupils prefer the teacher’s help. The opposite of dependence is independence and it refers to a situation in which the pupils perceive their activities to be “self directed” (even though the teacher may have helped create the perception) and they do not expect directions from the teacher. In the face of difficulties pupils prefer to at least try their own solutions before seeking the teacher’s help. If teacher direction is given pupil feel free to evaluate it in terms of the requirement of the learning activities.

A pertinent question that arises at this juncture is: What is the relationship between the learning potential of pupils and their level of dependence? Authors (e.g. Adegoke, 2003; Flanders & Flanders, 1967) opined that learning potential of pupils is inversely related to their level of dependence within reasonable and practical limits of classroom organization. In a condition of high dependence, a pupil is too concerned with his or her relationship to the teacher to be completely objective about the learning task. Objectivity, according to Lewin (1935), cannot arise in a constraint situation; it arises only in a situation of freedom.

However, it must be emphasized that the conditions of dependence or independence are created in the classroom by the teacher’s choice of influence. According to Amidon and Flanders (1967), one can conceive of *indirect influence* and *direct influence* which, under appropriate circumstances, determine the degree of dependence. These two kinds of influence can be defined, in terms of verbal behavior which the teacher exhibit. *Indirect influence* is at play in the classroom when the teacher gives maximum opportunity to the students to participate in the teaching-learning activities in the classroom i.e., he or she solicits for the opinion or ideas of the pupils, applies or enlarges on these opinions, or ideas, praises or encourages the participation of pupils, or clarifies and accepts their feelings. *Direct influence* is at play in

the classroom when the teacher adopts lecture method, states his or her own opinion or ideas, or justifies his or her authority or the use of the authority, directs the pupil's action and, or criticizes pupil's behavior. The original and modified forms of Flanders' (1961) category system can be used to effectively assess *indirect* and *direct teacher influence* in the classroom. In this study the modified form of Flanders system was used (see Appendix 1).

In the laboratory experiment carried out by Amidon and Flanders (1967), using 140 dependent-prone students selected from Minneapolis school district in the USA, it was shown that dependent-prone junior high schools students were more sensitive to differences in pattern of teacher influence. More over, dependent-prone students learned less geometry when exposed to rigid and direct pattern of teacher influence than they did with an indirect pattern of teacher influence. In the same vein, Adegoke (2003) in a quasi experimental study carried out in Nigeria, a completely different culture, found that dependent-prone students learned less geometry when exposed to rigid and direct pattern of teacher influence than they did with an indirect pattern of teacher influence. These researchers interpreted their findings in terms of the probable effects of teacher influence on dependent-prone students. They assumed that dependent-prone students are more sensitive to the direct aspects of the teacher's behavior. As the teacher becomes more directive, this type of students finds increased satisfaction in more compliance, often with less understanding of the problem-solving steps carried out especially in highly organized school subject as mathematics. Adegoke (2003), and Amidon and Flanders (1967) opined that it is only when a student is free to express his or her doubts, to ask questions and gain assurance, does his or her understanding can keep pace with his or her compliance to the authority figure. Lacking this opportunity, compliance alone may become a satisfactory goal and content understanding may be subordinated to process of adjusting to teacher direction.

Although, some authors (e.g., Loas et al, 2005; Lewin, 1935; Vilhjalmsson, Kristjandottir, & Sveinbjamardottir, 1998) regard dependence as a flaw or deficit in functioning, the dependent individual's concern with obtaining and maintaining ties to authority figures often leads to adaptive achievement – and health – promoting behaviors. For example, according to Bornstein and Kennedy (1994), high levels of dependence are associated with strong academic performance among high school students. Bornstein and Kennedy (1994) opined that this was so because the dependent – prone adolescents are concerned with pleasing parents and teachers and this usually prod them to perform well academically.

Previous researches on dependence, teacher influence and cognitive achievement (e.g. Adegoke, 2003; Amidon & Flanders 1967) were concentrated on geometry, which is an aspect of mathematics. Can the findings of these researchers be generalized to other aspects of mathematics? In view of the assertion of Bornstein and Kennedy (1994) that dependent proneness can lead to adaptive achievement promoting behavior among high school students, it is certain that the issue of dependent-proneness is far from being resolved. No doubt, the findings of Bornstein and Kennedy (1994) are scarcely consonant with some other authors (e.g. Adegoke, 2003; Amidon & Flanders 1967). Therefore it seems reasonable to suggest that more studies are needed in the area of dependent proneness, and students' cognitive achievement in other aspects of mathematics. More over it is necessary to provide more information on the effect that teacher influence can have on dependent-prone students, especially when learning highly structure subjects like mathematics. This study was therefore designed to find out the extent to which indirect teacher influence can enhance or inhibit the learning of algebra by dependent-prone students in senior secondary school two.

A close observation of the trends in the performance of Nigeria candidates who sat for the senior secondary school certificate examination (SSCE) between 2005 and 2009 shows that on the average, less than 25% of the total candidates made distinction and credit level passes (West African Examination Council [WAEC], 2009). A closer look at the Chief Examiner's Report, General Mathematics, Paper II, WAEC 2005 – 2009 point to an aspect in which majority of candidates appear to have major problems. This aspect of mathematics is algebra. In the recently published Examiner's Report, WAEC, Nigeria, May/June 2009, the Chief Examiner, emphasized that students/candidates demonstrated the following weakness:

- ✚ Inability to solve word problems
- ✚ Inability to solve equations that contain fractions

No doubt, solving word problems require critical, careful and analytic reading, comprehension of operational techniques, and skills in translating the verbal statements into algebraic language. Students must learn and develop these skills before they can successfully cope with the fundamentals of algebra and word problems in mathematics. The question that arises now is: Should the teacher assume the sole responsibility for giving training to students in analytic reading and problem solving skills through direct influence? Or should the teacher encourage the students develop analytic reading and problem solving skills on their own



through indirect influence? Which method will make the students proficient in solving word problems?

Cognitive psychologists and educators have long been interested in understanding the individual differences in cognition and their impact on learning and instruction. There are various recognized cognitive styles available in the literature, among which are visual/haptic, visualizer/verbalizer, leveling/sharpening, serialist/holist, and field dependent/independent (See, Jonassen & Grabowski, 1993 for an extensive overview and the synthesis of related research). Although various forms of cognitive styles have been introduced and different instruments have been developed to assess them, in this study, the author focuses on field dependence/field independence dimensions.

Field dependence/field independence is one of the ways of determining individual cognitive style preferences. It distinguishes individual learners in terms of the way in which they analyze and process information. The field dependent individuals rely more on external references, and focus on individual parts of an object. They tend to solve problems through common sense and intuition and use a trial-and-error approach. At the opposite pole, the field independents persons rely more on internal references, perceive objects as a whole, and tend to reduce problem situations to a set of underlying causal relationship (Witkin, Moore, Goodenough & Cox, 1977)

According to Witkin and Goodenough (1981), people are termed field independent (FI) if they are able to abstract an element from its context, or background field. In that case, they tend to be more analytic and approach problems in a more analytical way. Field dependent (FD) people, on the other hand, are more likely to be better at recalling social information such as conversation and relationships. They approach problems in a more global way by perceiving the total picture in a given context.

Daniels (1996) summarizes the general tendencies of field dependent and independent learners as follows:

Field-dependents:

- ✚ Rely on the surrounding perceptual field.
- ✚ Have difficulty attending to, extracting, and using non salient cues.
- ✚ Have difficulty providing structure to ambiguous information.

- ✚ Have difficulty restructuring new information and forging links with prior knowledge.
- ✚ Have difficulty retrieving information from long-term memory.

Conversely, field-independents:

- ✚ Perceive objects as separate from the field.
- ✚ Can disassemble relevant items from non-relevant items within the field.
- ✚ Provide structure when it is not inherent in the presented information.
- ✚ Reorganize information to provide a context for prior knowledge.
- ✚ Tend to be more efficient at retrieving items from memory (p. 38)

Cognitive style has been reported to be one of the significant factors that may significantly influence students' cognitive achievement in various school subjects (see, Dwyer & Moore 1995; Lynch, Woelfl, Hanssen & Steele, 1998, Tinajero & Paramo, 1997). For example, Dwyer and Moore (1995) investigated the effect of cognitive style on achievement with 179 students who enrolled in an introductory education course at two universities in the United States. They found field independent learners to be superior to field dependent learners on tests measuring different educational objectives. The researchers concluded that cognitive style had a significant association with students' academic achievement. Tinajero and Paramo (1997) investigated the relationship between cognitive styles and student achievement in several subject domains (English, mathematics, natural science, social science, Spanish, and Galician). With the sample of 408 middle school students, the researchers asserted that cognitive style was a significant source of variation in overall performance of students. That is, field independent subjects outperformed their field dependent counterparts. However, some authors (e.g. Altun & Cakan, 2006) found that there was no significant relationship between cognitive styles and academic achievement. Further more, some authors (e.g., Cakan, 2000; Witkin, Moore, Goodenough & Cox, 1977) have shown that field-independent and field-dependent students do not differ in learning ability but may respond differently to the content being presented as well as the learning environment.

Although considerable research has been conducted on the impact of field dependence/ independence and academic achievement, the relationships between FD/FI cognitive style and learning, including the ability to learn from social environments (Summerville, 1999), and the impact of cognitive styles on the use of learning strategies (Jonassen, 1988; Liu & Reed, 1994), indeed very few studies have examined the impact of cognitive styles on dependent-prone students' learning outcomes in mathematics. This explains why this author

was interested in assessing the main as well as the interaction effect of treatment and cognitive style on dependent-prone students' learning outcomes in algebra. Specifically, the following three hypotheses were advanced for testing.

Hypothesis One: Dependent-prone students in the indirect teacher influence group will perform significantly better in mathematics than their colleagues in the direct teacher influence group.

Hypothesis Two: Dependent – prone students whose cognitive style preference is field dependent will perform better than their field independent colleagues in mathematics.

Hypothesis Three: Field dependent students in the indirect teacher influence group will perform better than their colleagues in the direct teacher influence group.

## Method

### *Participants*

The sample comprised 270 (117 boys and 153 girls) dependent-prone senior secondary school one students drawn from fourteen senior secondary schools in Isokan, Irewole, and Ayedade Local Government Areas, Osun State, Nigeria.. Their ages ranged between 15 and 17 years (Mean Age = 15.8 years; SD = 0.98 years). In each of the schools that were sampled, an arm of science class as well as all the students in the class participated in the study.

### *Instruments and procedure*

*Materials:* Four instruments were used. These were: (a) Dependence-proneness Test (DPT), Group Embedded Figure Test (GEFT), Mathematics Achievement Test (MAT), and Modified Flanders Interaction Categories System (MFICS).

*DPT:* This was a highly reliable 20-item instrument developed by the author to measure the degree of student's dependency on the encouragement, suggestions and directions of the teacher in solving problems when confronted with difficult situations. It was also used to measure the degree of the student's dependence on teacher's influence in learning tasks. Dependence-proneness is a personality trait; therefore *a priori method* was adopted for its construction and validation. Because a dependent-prone individual frequently has a strong incli-

nation to look to others for support, guidance and reassurance, even in situations where he or she seems capable of initiating tasks on his or her own, items were written about his or her preferring to seek for support, encouragement, reassurance and guidance from the teacher. There were four components and each component consisted of five items in line with Bornstein conceptualization of dependent personality. The stem of the items was: "To what extent does each of the following statements apply to you?" Examples of items included: – having a marked need for guidance from others (motivational component); having a strong feeling of self as powerless (cognitive component); having a tendency to become anxious when required to function independently (affective component); having a strong tendency to seek help from others (behavior component). The test was placed on a 4-point Likert scale of from Very much like me (VMLM), to Very much unlike me (VMUM) with scores of 4, 3, 2, 1 for positively stated items and reversed for negatively stated items. It had a reliability index of 0.73 (Cronbach Coefficient Alpha).

Before the experiment, DPT was administered to 587 students who were members of the 12 classes that were sampled. Based on their scores in the dependent-proneness test the students were classified into three groups: dependent-prone students; independent-prone students, and moderate students. Students whose DPT scores were within the top 25% of each class were identified as dependent-prone students. Those whose DPT test scores were within the lowest 25% of each class were identified as independent-prone students. Those within the median position were classified as moderate students. Based on their scores in DPT, 270 students (117 boys and 153 girls) were identified as dependent prone-students. Their average score in DPT was 61.9. One hundred and ninety eight (103 boys and 95 girls) were identified as independent-prone students. Their average score in DPT was 23.3. The remaining 112 students (65 boys and 57 girls) were classified as moderate students. Their average score in DPT was 40.7. The average DPT scores among these three groups of students were found significantly different  $F(2, 584) = 346.29, p < .001$ .

*GEFT*: Although various forms of cognitive styles have been introduced and different instruments have been developed to assess them, Witkin et al.'s (1971) Group Embedded Figures Test has been applied most commonly. There are two reasons for choosing GEFT in this study. First, the instrument is a non-verbal test and requires only a minimum level of language skill for performing the tasks (Cakan, 2003). Another reason is that psychometrical properties

of the instrument have been investigated in cross-cultural settings and accepted as quite reasonable.

Therefore, the Group Embedded Figures Test (Witkin et al. 1971) was used to determine the participants' cognitive styles. The test consisted of 3 sections. The first section was given for practice purposes and included 7 items. Both the second and third sections contained 9 items. The total time for completing the test was 12 minutes. The instrument required each individual to trace a specified simple figure that was embedded within a complex design. A subject's total score was formed by a number of simple figures correctly traced in section 2 and 3 of the test. The possible score that one could make ranged from 0 to 18. Although Witkin et al. (1971) do not specify a clear cut off score for determining field dependent and independent individuals, the 27% rule created by Cureton (1957) is applied for classification purposes. Before the experiments, GEFT was administered to 587 students from the 14 classes to determine their FI/FD cognitive style preference. During the administration of the GEFT, the exact procedures set out in the technical manual (Witkin, et al., 1971) regarding time limits and directions were closely followed. Students whose embedded figure tests were within the upper 27% were identified as field independents (FI). Those with test scores within lowest 27% were identified as field dependents (FD). Through this procedure, among the 270 dependent-prone students 134 were identified as FI students. Their average score in GEFT was 11.74. The FD group consisted of 136 dependent-prone students and their average score in GEFT was -1.85. A significant difference in the average scores was found between the FI and FD groups from ANOVA analysis,  $F(1, 585) = 65.49, p < .05$ . This revealed that the two groups did have significantly different cognitive styles in terms of FI/FD.

*MAT*: This consisted of 40 items on algebra and simultaneous linear equations as prescribed by the Mathematics Curriculum prepared by the Federal Ministry of Education, Abuja, Nigeria. The items were developed from topics that were meant for 1<sup>st</sup> Term of 2009/2010 academic sessions (September - December) in Osun State School Calendar. The reliability coefficient of MAT was 0.69 while the discriminating and difficulty indices of the items ranged from 0.65 to 0.72. The content validity was determined and it was found that the test was valid in terms of content; this was through the table of specification based on knowledge, understanding and thinking.

*MFICS*: This was used to measure verbal classroom behavior that occurred in each of the classrooms. This was carried out by two observers. The observers were graduate students at

the institute of Education, University of Ibadan, Nigeria. MIFCS is one of the instruments being used for the training of Graduate students in Observational Techniques in the Institute of Education, University of Ibadan, Ibadan, Nigeria. It was an adapted version of Hough's (1966) instrument.

### *Procedure*

Eighteen research assistants were recruited for the study. This comprised 12 instructors and six observers. The instructors were graduate students taking mathematics and physics methods in the Department of Teacher Education/ Institute of Education, University of Ibadan, Nigeria. The six observers were graduate students in the Institute of Education, University of Ibadan. They had received formal training in observational techniques and well versed in the use of FIACS and MFICS. The instructors had received some formal training on what constitutes FIACS and MFICS during sessions on mathematics methods. Nevertheless for the purpose of this study we had 11 review sessions for four working days. During the first and second day of the training we reviewed video recordings on mathematics teaching which show integrative teachers (indirect influence) and dominative teachers (direct influence). On the third day, six of the instructors were randomly assigned as integrative teachers and six were assigned as dominative teachers. On the fourth day each instructor carried out two micro teachings. The micro teachings were assessed using MFICS. We were convinced that all the instructors were able to exhibit the characteristics inherent in the two contrasting approaches. At the end of the four days training the instructors were assigned to the groups. The instructors assigned to the experimental groups were instructed to adopt indirect teacher influence while those assigned to the control group were instructed to adopt direct teacher influence method. Six intact classes were randomly assigned to each of the two contrasting groups.

Although one would think it is better to bring the identified dependent-prone students into a separate room and then administer the treatments in a water tight laboratory. In this study, this was not done because of the following reasons. One, in Osun State, and indeed in all States in Nigeria, the government and the school heads usually frown at the idea of breaking classes for the purpose of conducting experiments. Two, a typical class, in all cultures, consists of students with different personality orientation. The teacher must strive to identify all these traits and then apply the most appropriate method. Although the teacher can organize remedial program for low achieving students, all the students, irrespective of personal orientation, must first be taught in the classroom during the normal school periods. More impor-

tantly, across globe, research has shown that when issue borders on mathematics not many students exhibit independence. Rather in mathematics class many students tend to exhibit dependent behavior (Adegoke, 2003). For example, Adegoke (2003) found that 69.7 % of students who were sampled in his study showed dependent personality in mathematics classes. Indeed many students prefer the teacher to solve mathematical problems for them rather than solving the problems on their own, and also prefer to adopt the teacher's method rather than trying their own method. In view of this, this author believes the information being provided through this quasi-experimental study involving all the students in the intact class will be more beneficial to all stakeholders in mathematics education. Nevertheless, efforts were made to reduce all contaminants that could have confounded the findings. For example, classrooms were randomly assigned to experimental groups. Also the students were not pre-tested and instead, their math scores in the State-wide Junior Secondary School Certificate Examination (JSSCE) were used as covariates.

### *Design*

#### *Experimental Group: Indirect Teacher Influence*

There were six classrooms designated as A, B, C, D, E, and F. In this group there were 137 dependent-prone students. The treatment in the group consists of soliciting the opinions or ideas of the students, applying or enlarging on those opinions or ideas, praising or encouraging the participation of students or clarifying and accepting their feelings. The behavior pattern of the teacher was essentially integrative, inclusive, and student-centered. The teacher expanded the students' opportunities for active participation in the teaching and learning of solving word problems and simultaneous linear algebra in the classroom during the experimental weeks. For example teachers provided opportunities for students to ask questions to which the teacher encouraged other students to provide answers. It was only when none of the students could provide answers that the teacher gave hints on how to solve the problem. The teacher encouraged the students to solve problems as contained in their math text books.

#### *Control Group: Direct Teacher Influence*

There were six classrooms designated as G, H, I, J, K, and L. In this group, there were 133 dependent-prone students. The treatment in this group consists of stating teacher's own opinion or ideas and directing the student's action. The teacher presented the materials - solv-

ing simultaneous equations and word problems in form of lecture. The teacher talked most of the time, explained the materials, while the students listened attentively and took notes. The students asked questions to which teacher provided answers. The teacher also asked questions to which the teacher provided answers whenever they were unable to provide correct answers. The teacher encouraged the students to solve problems as contained in their math text books.

The treatments in each of the contrasting groups lasted for three weeks. There were four sessions of thirty-five minutes per session per week. At the end of the treatments, post test of mathematics achievement was administered to the students. In order to determine the extent to which the teachers were able to exhibit the pattern of teacher influence teacher-students interactions during sessions were observed and video taped. In each of the 12 schools, 12 teaching sessions were observed. This meant that each of the teachers was observed thrice a week. Each observation lasted 35 minutes. Classifications of observations usually started immediately the teacher started the lesson. All observations were made during the time scheduled for mathematics on the official school's timetable - this was to avoid disruptions of the school's official schedules.

During the sessions, whenever the teacher or the student talked, each statement made was classified every five seconds according to Flanders' guidelines. The sessions in each class were video taped and verbatim transcripts were later analyzed. The validity and reliability of the observations were verified by studying the video recordings that were made of the sessions. Using Scott's coefficient "pi" method, the reliability indices of the observations ranged between 0.81 and 0.88.

### *Data Analysis*

The author used frequency counts, percentages, Chi Square, mean, standard deviation, and Analysis of Covariance (ANCOVA) to analyze the data.

### **Results**

The percentages shown for each category were based on 5,335 tallies in the indirect teacher influence group and 6,681 tallies in the direct teacher influence group. Table 1 presents the classification of teacher-students statements into interaction categories in percentages as recorded by the two trained observers.



Table 1. Percentage of Tallies in each interaction categories

Category definition	Treatment	
	Indirect Influence	Direct Influence
<b>Teacher Talk</b>		
1. Praise and encouragement	5.35	3.52
2. Clarification and development of ideas suggested by pupils	12.48	8.51
3. Ask questions	15.58	8.05
4. Answer students questions	11.08	4.81
5. Lectures	18.50	34.51
6. Gives Feedback	5.35	4.61
7. Gives directions	3.67	11.18
8. Justifies authority	3.03	4.54
<b>Student Talk</b>		
9. Response	6.10	2.10
10. Emitted	7.13	1.97
11. Asks questions	8.25	3.90
<b>Silence</b>		
12. Directed Activity	0.50	0.80
13. Contemplation	0.38	0.49
14. Demonstration	1.50	3.98
15. Grading pupil work	0.75	1.52
<b>Non Functional</b>		
16. Irrelevant behavior	0.35	4.51
Total tallies on which the percentages are based	5,335	6,681

Table 1 show that the essential differences between direct and indirect treatments were: On the average,

- ✚ The teachers in the direct teacher influence group lecture and give more direction than teachers in the indirect teacher influence group.
- ✚ The teachers in the indirect teacher influence group ask more questions and get more students' participation than teachers in the direct teacher influence group.
- ✚ The teachers in the indirect teacher influence group praises, encourages and clarifies students ideas more frequently than teachers in the direct teacher influence group
- ✚ The teachers in the direct teacher influence group criticize students more frequently than teachers in the indirect treatments.

The difference in the classification was statistically significant.

A 2 X 2 ANCOVA test was conducted to determine the effects of indirect and direct teacher influence on dependent-prone students' cognitive achievement in mathematics. The moderating effect of cognitive style preferences (FI/FD) on dependent-prone students' achievement in mathematics was also examined. Students' math previous scores in JSSCE were used as covariates. The ANCOVA test for homogeneity of regression slopes showed that factors and covariate interactions were not significant.

### *Descriptive Statistics*

Although the main focus of this study is on the students who were classified as dependent – prone students, analysis of all the students' scores (i.e. both the independent- prone and dependent prone) shows that independent – prone students performed better ( $M = 25.72$ ;  $SD = 3.49$ ) than their dependent-prone colleagues ( $M = 20.81$ ;  $SD = 4.52$ ). More importantly, on the average, students in the indirect teacher influence group performed significantly better than students in the direct teacher influence group. Table 2 presents the group means and standard deviation of dependent-prone students' scores in MAT.

Table 2. Descriptive Statistics of Mathematics Achievement

Group	N	Mean	Std. Dev.	Std. Error
<b>Treatment</b>				
Indirect Teacher Influence	136	22.01	6.38	.49
Direct Teacher Influence	134	19.61	5.13	.50
<b>Cognitive Style Preferences</b>				
FD	144	21.33	6.32	.50
FI	126	20.30	5.53	.47

Comparison of the dependent-prone students' mean scores in mathematics as shown in Table 2 indicates that dependent-prone students who learnt mathematics under indirect teacher influence performed better ( $M = 22.01$ ;  $SD = 6.38$ ) than their colleagues who learnt mathematics under direct teacher influence ( $M = 19.61$ ;  $SD = 5.54$ ). Table 2 also shows that dependent-prone students' whose cognitive style preference was FD had a mean score of 21.29 ( $SD = 6.32$ ); while the mean score of those whose cognitive style was FI was 20.31 ( $SD = 5.53$ ).

= 5.53). Table 3 presents the summary of ANCOVA and it was used to test the significance of the observed differences in the mean score of the dependent-prone students in MAT.

Table 3. ANCOVA Table for MAT Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squa- red
Corrected Model	243.123	4	60.781	7.624	.000	.103
Intercept	3185.903	1	3185.903	399.636	.000	.601
Covariate	12.522	1	12.522	1.571	.211	.006
TRT	86.639	1	86.639	10.868	.001	.039
CSP	17.424	1	17.424	2.186	.140	.008
TRT * CSP	112.359	1	112.359	3.322	.000	.050
Error	2112.585	265	7.972			
Total	31455.000	270				
Corrected Total	2355.707	269				

Note: TRT = Treatment; CSP = Cognitive Style Preferences

#### *Hypothesis One: Treatment Effect*

Table 3 which is the ANCOVA test shows that treatment (indirect and direct teacher influence) had statistically significant effect on the dependent variables (cognitive achievement in mathematics),  $F(1, 265) = 10.87, p < .05$ . The effect size (24.7%) was fair. Therefore the null hypothesis which states that there is no statistically significant main effect of treat-

ment (direct teacher influence versus indirect teacher influence) on dependent-prone students' cognitive achievement in mathematics after removing the covariate (students' score in junior secondary school mathematics) was rejected. There was statistically significant effect of treatment on students' cognitive achievement in mathematics. The observed mean difference between students who learnt mathematics in the indirect influence group and their colleagues who learnt mathematics in the direct teacher influence was statistically significant.

*Hypothesis Two: Effect of Cognitive Style Preferences*

ANCOVA summary of results as presented in Table 3 indicates no statistically significant effect of cognitive style preferences on students' cognitive achievement in algebra dependent variables,  $F(1, 265) = 2.19, p = .140$ . Therefore the null hypothesis which states that there is no statistically significant effect of cognitive style preference on students' cognitive achievement in achievement after removing the effects of covariate (students' score in junior secondary school mathematics) was not rejected. There was no statistically significant main effect of main effect of cognitive style on dependent-prone students' cognitive achievement in mathematics after removing the covariate (students' score in junior secondary school mathematics).

*Hypothesis Three: Interaction Effect of Treatment and Cognitive Style Preferences*

ANCOVA summary as shown in table 3 shows that there was statistically significant 1<sup>st</sup> order interaction effect of treatment and cognitive style preference,  $F(1, 265) = 14.09, p < .001$ . Table 4 shows that in the indirect teacher influence group, dependent-prone students whose cognitive style was FD performed significantly better than their colleagues who were FI. As Table 4 shows, it is interesting to note that in the direct teacher influence group, dependent-prone students' whose cognitive style was FI performed significantly better than their colleagues who were FD. Nevertheless, to disentangle the interaction, a plot of the graph of the dependent-prone students' scores as shown in Table 4 was carried out.

Table 4. Descriptive Statistics of MAT scores - Treatment \* Cognitive Style Preference

Group	N	Mean	Std. Dev.	Std. Error
Indirect Teacher Influence				

FD	62	23.94	6.67	.52
FI	74	20.38	5.68	.56
 Direct Teacher Influence				
FD	64	18.72	6.67	.52
FI	70	20.23	5.40	.56

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## Discussion and conclusion

The results of this study showed that dependent-prone students who learned mathematics in the classrooms where the teacher gave fewer directions, less criticisms, less lecturing, more praises and asked more questions, had higher cognitive achievement than their colleagues who learnt mathematics in the classrooms where the teacher dominated teaching and learning activities. These findings are consistent with the results of previous authors (e.g., Bullard & Felder, 2007; Felder & Brent, 2003; Motsching-Pitrik & Holzinger, 2002). More importantly, the results of this study are in tandem with the findings of authors (e.g., Adegoke, 2003; Amidon and Flanders, 1961) who found that dependent-prone students taught by teacher whose classroom teaching behavior was classified as indirect influence showed superiority in academic achievement in geometry over dependent-prone students who were taught by teacher whose classroom teaching behavior was classified as direct teacher influence.

These findings give credence to the notion that restricting students' freedom of participation in the cycles of classroom activities tend to increase dependency, and consequently decreases achievement. On the other hand, as the findings of this study suggest, expanding students' freedom of participation in the cycles of classroom learning activities tend to decrease dependency and consequently' increases achievement. Sustained direct influence by a teacher as the findings of this showed, results in increased compliance and when this is maintained over an extended period of time, pattern of dependent behavior increased with a consequent decrease in achievement.

One major implication of these findings is that closer supervision through the use of direct talk teaching strategy (i.e., the teacher talk dominates the teaching-learning process), an all common antidote to lower achievement in mathematics, sciences and other highly organized school subjects may after all be more harmful than beneficial to dependent-prone students. The results of this study showed that dependent-prone students' learning outcomes will be enhanced when they are taught by teachers who adopt student centered approach to teaching. Stu-

dent centered approach to instruction is the hall mark of indirect teacher influence in the classroom. This approach to instruction has repeatedly been shown to be superior to the traditional teacher-centered approach to instruction (Felder, 2010). This conclusion applies whether the assessed outcome is short-term mastery, long-term retention, or depth of understanding of course material, acquisition of critical thinking or creative problem-solving skills, formation of positive attitudes toward the subject being taught, or level of confidence in knowledge or skills. Past studies which dwell on establishing the factors which promote students' learning outcomes have shown that teachers as well as the type of student – teacher interpersonal relationship are major factors. Researchers (e.g. De la Funte & Justica, 2007; Rodríguez, Gutiérrez, & Pozo, 2010) have shown that teaching in which teachers elicit positive response from the students, formulating significant questions and posing important problems rather than simply offering information tend to help students understand and perform well in their studies. On the other side, not allowing students sufficient time for full dedication to the task, emphasising getting through the programme at the expense of depth are inimical to students' academic performance. play an important role in students' learning outcomes. The findings of this study lay credence to these assertion. When teachers allow students to participate effectively in the teaching and learning activities in the classroom, students tend to do well in academic work.

The findings of this study show that cognitive style of the dependent-prone students had no statistically significant effect on their cognitive achievement in mathematics. Earlier research suggested a significant association between cognitive styles and academic achievement (Lynch, Woelfl, Hanssen & Steele, 1998; Moore & Dwyer, 2001; Tinajero & Paramo, 1997). Yet, unlike previous studies, this study revealed no significant association between academic achievement of dependent-student prone students and their cognitive styles. Although there is a dearth of research that bears on cognitive style and achievement of dependent-prone students, the findings of this study bear some resemblance with some authors (e.g., Altun & Cakan, 2006; Cakan, 2000; Witkin, Moore, Goodenough & Cox, 1977) who have shown that field-independent and field dependent students do not differ in learning ability but may respond differently to the content being presented as well as the learning environment.

However, as the results of this study have shown, the learning environment as dictated by teacher influence interacted with dependent-prone students' cognitive style preferences. The interaction had statistically significant effect on dependent-prone students' achievement in mathematics. Dependent-prone students whose cognitive style preference was classified as FD per-

formed better than their colleagues who were classified as FI while learning mathematics under the teacher whose classroom behavior was integrative (i.e., indirect teacher influence). It therefore follows that how well a dependent-prone student will fare in academic achievement especially mathematics depends to a large extent on the interaction between his or her cognitive style preferences and teacher classroom behavior. These findings uphold the findings of previous authors (e.g., Cakan, 2000; Summerville, 1999) who were of the opinion that field-independents and field dependents do not differ in learning ability but may respond differently to the content being presented as well as the learning environment.

The findings of this study showed that learning outcomes in mathematics of dependent-prone students can be enhanced when teachers provide maximum opportunities for the students to take active part in the teaching and learning activities in the classroom. More importantly, the findings of this study show that field-independent and field dependent students do not differ in learning ability but may respond differently as a result of differences in learning environment. Dependent-prone student whose cognitive style preference is FD tends to benefit more from the teacher who exhibits indirect influence behaviour in the classroom.

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