



EFFECTS OF INSTRUCTIONAL STRATEGIES ON HIGH SCHOOL STUDENTS IN MATHEMATICS: WEST-GOJAM ZONE, ETHIOPIA

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ABSTRACT

This study was designed to examine the possible effects of instructional strategies on mathematical discourse. The effectiveness, retention, application and the usefulness of teacher-centered instruction were in question. To obtain data, questionnaire, classroom observation, and semi-structured interviews were used. A total of one hundred fifty-six teachers and five hundred sixteen students from the entire sample schools were selected using simple random sampling technique for the questionnaire and classroom observation. Twenty teachers and thirty-five students were interviewed. The quantitative data were analyzed using one sample t-test whereas the qualitative one was analyzed using descriptive interpretations. The findings implied that improving teachers' status has a great impact on mathematics discourse. Furthermore, the findings showed that the kind of appropriate teaching methods for a particular topic, cooperative learning and learning mathematics outside the classroom have a strong effect on mathematics discourse. The results spotlight that both the cognitive and material decisions teachers make, in relation to classroom discourse, significantly influence learning. In general, the results demonstrated that teachers are at the essence of effective Mathematics education. However, the findings also disclosed that there are disconfirming constraints pretending teachers' effectiveness in teaching Mathematics. An awareness of these elements can assist increase a teacher's effectiveness if they are addressed successfully. Recommendations are also forwarded.

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INTRODUCTION

Many teachers are using the lecture method as a teaching strategy in their mathematics courses. However, some instructors reject using the lecture method to their students. Both groups need to find out more about effective teaching strategies. For instance, there are many research findings backing the thought that cooperative methods have a positive effect on student achievement in almost any discipline (Bennett, 2015). However, the outcomes of findings on the effectiveness of collaborative work are not always positive, and so, some researchers have contended that collaborative work in a classroom may not be practicable in general (Qamar, Ahmad, & Niaz, 2015; Brown & McIlroy, 2011).

Background Research

Nowadays, the lecture method is the most commonly used teaching strategy in classrooms (Lammers & Murphy 2002).

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Yet, according to Fredrick & Hummel (2004), this strategy generally misses many of the elements of active learning, such as problem-solving, in particular, critical thinking, self-pacing, and the boost of debate and group discussion. Many types of researches describe the various benefits of integrating Instructional Based-Learning strategies in the higher education classroom, most of which are endorsed by the National Science Foundation (National Science Foundation, 2014). According to Krapp & Prenzel (2011), motivational constructs, such as interest in mathematics, are significant effects of educational actions and are fundamental elements concerning the young generations' readiness for womb-to-tomb learning as an essence-acquisition in cognition-established societies. However, if teachers can actively employ their students in classroom discussion, they are likely to employ them in more significant and continued learning experiences (Walshaw & Anthony, 2008). A newly evolved treatment, video-based Teacher Professional Development, (Gröschner, Seidel, Kiemer, & Pehmer, 2014), positively impacted teachers' works as well as students' learning styles of self-defined learning motivation and their development of interest in the subject.

Thus, video-based kind of learning clears up better learning in comparison to more common practices of professional development in the German context (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011). Furthermore, it contributes to meaningful classroom discourse (specifically, teacher questioning and feedback) for students' situational and semi-permanent motivational preferences. Walshaw and Anthony (2008) distinguish two main teaching strategies in fertile the classroom treatment: elucidating discussion participation rights and duties between the teacher and students, where the target is to engage students in classroom conversation, and scaffolding students' ideas, e.g. by giving individual feedback, in a productive way to move thinking forward. Various researchers on mathematical debate and science inquiry comment on the importance of these tasks in producing fruitful classroom discourse (Furtak, Seidel, Iverson, & Briggs, 2012). The two activities can especially be conceived through productive forms of teacher questioning and purposeful feedback (Jurik, Gröschner, & Seidel, 2014). Given the prepotency of insignificantly focused classroom discourse, encouraging teachers to modify their dissertate behavior is a tangible method of classroom change for the better as a result of correcting abuses. On the foundation of the teaching cycle thought of designing, teaching and reflecting (Borko, Jacobs, Eiteljorg and Pittman, 2008), Gröschner, Seidel, Kiemer, *et al.* (2014), Gröschner, Seidel, Pehmer, and Kiemer (2014) evolved a video-based Teacher Professional Development intervention for redefining classroom discourse practices ('Dialogic Video-Cycle', DVC) and designated how to carry out it successfully with mathematics and science teachers (Gröschner, Seidel, Kiemer, *et al.*, 2014).

Stress is often placed on procedural smoothness of mathematical algorithms through iterated practice, thus striking the mathematics teaching methods more commonly known as recitation and belt down (Brahier, 2013). Even though traditional teaching strategies have been used in mathematics classes for tens of years, research has shown that these methods may lead to students who seldom ask in the classroom, absorb in arguing and meaning-making, or think of themselves as problem solvers (Boaler, 2008). In previous research, pre-service elementary teachers have reported that their mathematics anxiety was caused by having to complete regularly programmed tests, mathematics classes being drilling, course material being taught too promptly, and a big stress aimed at obtaining the correct answer (Harper & Daane, 1998). All of these are features often found in classes concentrated on traditional teaching methods. The learning theory of constructivism is based on the work of Jean Piaget and Lev Vygotsky and is the leading theory of learning today (Brahier, 2013). Therefore, changing students' classroom experiences into meaningful ones that develop their interests by changing the prominent routines of classroom interactions and discourse is important. Productive classroom discourse is a key aspect of students' development of interest in the subject. Ascertaining the impressions of teachers is crucial to changing teachers' classroom experience of actual teaching. This study analyzes teachers' beliefs and experience of actual teaching that are directly related to a search for knowledge-pointed mathematics instruction. The objective is to better sympathize with the nature of teachers' beliefs about mathematics teaching and learning and the associations between their beliefs and experience of actual teaching. In the end, the researcher hopes to inform the design of professional development approaches that will increase the knowledge-pointed teaching of

mathematics in classrooms. The National Council of Teachers of Mathematics (NCTM, 1991) 'Standards emphasize that mathematics need to be taught as a dynamic instrument for thought, not just as a circle of operations to be learned'. Observation on classroom experiences, however, has been shown to be effective in changing teachers' beliefs. Students' self-confidence as mathematical learners was also significantly associated with their teachers' self-confidence as mathematics teachers (Deborah J. Stipek!, Karen B. Givvin, Julie M. Salmon, and Valanne L. MacGyvers, 2001). Sound mathematical pedagogical knowledge helps teachers to "develop the flexibility for spotting opportunities that they can use for moving students' understanding forward" (Walshaw, 2012, p.185). As a result, an understanding of what quality mathematics pedagogy looks like, specifically in relation to the vision of communal production and validation of mathematical ideas, is still in its formative stages.

A number of factors may influence the teaching of mathematics but the syllabus and textbooks, teachers' knowledge (both subject matter and pedagogical knowledge), access to different relevant materials for the subject and students' attitude towards the subject plays an important role in the teaching/learning process. The development of syllabus and textbooks may be guided by the patterns and requirements of the examination system, rather than by the needs determined by a mix of criteria based on the child's learning requirement, aims of education and the socio-economic and cultural contexts of learners. It may encourage a dull routine, bored student's rote system of learning. "To give students a cup of water, a teacher should first have a bucket of water" (Lianhua Ning, 2009). This metaphor has clearly conveyed the importance of teachers' knowledge in teaching mathematics but not a sole determinant. Even in the society, nowadays there is a common belief which says if a mathematics teacher knows mathematics very well, he or she is the best person to teach mathematics. But several research findings have shown that the way of teaching is also one of the major components of mathematics teaching. It is a widely accepted fact that what and how mathematics teachers teach is linked to what they believe about mathematics and the teaching and learning of mathematics (Beswick, 2009).

Teaching is a complex, cognitively demanding process involving problem-solving and decision making. Given the vital role that particular content knowledge brings in achievement in complex domains (Chi, Glaser, & Rees, 1982), it follows that teachers' knowledge should be a principal factor in the study of teaching. As Khalid (2009) has explored, effective teaching involves teachers to decide "what aspects of a task to highlight, how to organize and direct the work of students, what questions to ask students having various levels of skillfulness, and how to help students without taking over the process of [mathematical] thinking for them" (p. 176). Conceptions of teachers as mere —facilitators or —managers whose work is to support a student's active efforts to come upon and rebuild knowledge through their own actions spares the central role of teachers in the pedagogical process. This issue can be exemplified with acknowledgment to Vygotsky's (1978) conception of the zone of proximal development. Vygotsky asserted that there is a difference between the developmental level at which a student can learn when working on his own and the level that he can hold while working with an adult or more accomplished peer.

Main Factors in effective instructional strategies

The Teaching-Learning Process

According to Silva (2006), the interaction between the elements of the educational environment: an institution (support), teacher (expert), student (apprentice) and subject (curriculum), guarantees the existence of the teaching-learning process. The educational environment described in this manner provides the process of teaching and learning based on a combination of resources (institution, teacher) and approaches (subject) so that the result (student learning) is achieved with optimal resource consumption (Cornachione Jr., 2004).

Teaching-Learning Methods

Mizukami (1986) stresses that all teaching and learning theories should be considered, analyzed, contextualized and criticized, since it is understood that the way the method is addressed or proposed may meet one or another educational phenomenon. The author identifies five methodological approaches that influenced teachers in Brazil: Traditional; Humanistic; Behaviorist; Cognitivist; and Socio-cultural. The traditional method places students in a passive position in relation to the teacher, who is the active agent responsible for transmitting his knowledge and experiences. It is for the student to absorb what was taught (Marion, 2001). According to Gil (2006), most teachers tend to put themselves in a position in front of the class; they behave as the discipline specialists; and teach to a group of interested students. Their actions are defined by the verbs "guide", "form" and "indoctrinate" (Gil, 2006). According to Freire (2002), the traditional approach molds education in the format "banking education" and identifies the teacher as the content narrator, with the sole aim of "filling" the listeners, in this case, the students, who in turn receive in their "containers" what is being pronounced. That said, the student "deposits" content, memorizes and repeats, and may not realize what it really means. This teaching is characterized by the teacher's verbalism and the memorization of the student (Gil, 2006). In parallel to the traditional approach, there is the Humanistic approach. According to Andrade (2002), in this approach, interpersonal relations and the development of the individual personality are observed. The stimulus is for the student to develop without interventions (Andrade, 2002). The teacher acts as a facilitator for learning, assisting students and ensuring their autonomy (Gil, 2006). The humanistic approach, in line with Mizukami (1986), cherishes the student's own experiences - the teacher does not teach but creates conditions for students to learn. Education is centered on the person of the student and on creating conditions for the intellectual and emotional development of the individual (Mizukami, 1986). The Behaviorist approach considers the teacher as the organizer and applicator of the means to ensure the efficiency and effectiveness of education, not caring about the more autonomous activity of the student (Silva, 2006). The Cognitivist approach, in turn, sees the teacher as responsible for creating challenging learning situations, and the student participates actively in the solution of issues problematized by the teacher (Silva, 2006). The Socio-cultural approach is conceptualized by Gil (2006) as an approach that emphasizes the socio-cultural aspects involved in the learning process. The agents involved (student and teacher), according to the same author, grow together, the teacher directs and conducts the process of teaching and learning, while the student determines

and is determined by the environment, being able to make changes in what is being experienced. Marion (2001), finally, highlights only two teaching-learning methods practiced in accounting courses. First, according to the author cited, the student is the passive agent in the learning process, featuring the traditional approach of teaching. The opposite happens in the second method, in which the student takes the role of an active agent, resulting in a more humanistic approach to teaching.

Types of Teachers that influence the Teaching-Learning Process

For the development of this study, the theoretical framework developed by Bordenave and Pereira (2012) was considered. The authors studied the effects of different personalities, the student and the teacher's, which interfere in the teaching-learning process. They concluded that the deficiency in the teaching method does not result only from an educational disability. The lack of teacher enthusiasm for his discipline and inability to engage students also influence the overall result of the group (Bordenave & Pereira, 2012). In the definition proposed by Bueno (2000), automats are people incapable of acting alone. That is how the student is treated in the "instructor" teachers' view: students are trained to recite definitions and remember what was exposed by the teacher. The highest authority in the classroom is exercised by the "instructor", and the students have few alternatives for the development of thinking (Bordenave & Pereira, 2012). To illustrate this type of teacher, Bordenave, and Pereira (2012) cite the professional preparatory courses but stress that it is common to find similar teachers at universities. The satisfaction and method of the teacher focused on content are, according to Bordenave and Pereira (2012), to systematically cover the subjects of their discipline. The exchange of ideas with the student to build the knowledge together is hardly accepted and understood to achieve the goal of teaching. This teacher profile is sure of the contents to be addressed and learned (Bordenave & Pereira, 2012).

MATERIALS AND METHODS

Research Design: Both qualitative and quantitative research designs are used. The instruments being used for this study were questionnaire, interviews and classroom observations. In order to measure teachers' subject matter knowledge and pedagogical knowledge (knowledge for teaching mathematics), the investigator developed a set of questionnaire items in the areas of the secondary school mathematics. To design the questionnaire, a group of mathematics teachers of Bahir Dar University analyzed the key principles and several curricula to determine what is involved in the teaching of the key principles for understanding. Items for each key principle were developed from this analysis to reflect the actual knowledge that teachers would need to teach for students' understanding.

Participants: Questionnaire and interviews were conducted for teachers and students. Its purposes were mainly to investigate the pedagogy of teaching mathematics and the confidence they have in their previous study. The interview questions might include their memories and experiences of concept learning from their secondary school up to their university level and their opinion on-job training. Moreover, items asking about teachers' educational degrees, diplomas or

Table 1. The effects of the number of services, academic status and awareness of the Curriculum on teachers' teaching

Variables	No	Expected mean	Observed mean	sd	df	Sig
Teachers' Service in Years	156	3	2.6	.802	155	.090
academic status	156	3	2.3	.459	155	.000
Rating teachers on the curriculum	156	3	3.1	1.33	155	.481

* significant at alpha value of 0.05

Table 2. The perception of students on frequency of lecture, contribution to the group and working mathematics outside the class

Variables	No	Expected mean	Observed mean	sd	df	Sig
Frequency of lecture	156	3	3.54	1.178	515	.000
Contribute to group	156	3	3.38	1.077	515	.000
Math outside class	156	3	2.81	1.259	515	.001

* significant at alpha value of 0.05

certificates received, courses are taken and grades earned were included. To assess the classroom practice of mathematics teachers, an observation checklist was developed. Standard procedures for questionnaire, inventory and checklist development and/or adaptation including the pilot study to try out whether or not appropriate instruments were followed to secure the validity and reliability of data gathering instruments.

Sampling procedures: Cluster sampling and Simple random sampling were used to select the schools and the classes. Purposive or judgmental (non- probability) sampling was used to select teachers and school administrators for the interview. Furthermore, convenience sampling was used to select students for interview.

RESULTS AND DISCUSSION

The data collected in the study were analyzed depending on the type of data collected. Both quantitative and qualitative methods are used in the analysis of the participants' responses. To analyze the teachers' subject matter and pedagogical content knowledge, and students' attitude towards mathematics, a one-sample t-test is employed. Data obtained using observation about teachers' classroom practices and inventory of the different supplementary materials relevant for the learning of mathematics are analyzed qualitatively.

Presentation of the Findings: This part deals with the analysis of results obtained from the questionnaire distributed to students and teachers of the five high schools situated in West Gojam, Amhara Regional state, Ethiopia. One hundred fifty-six teachers and five hundred sixteen students were involved in filling out the questionnaire. The questionnaire of the teachers constitutes 14 items categorized under three themes. Whereas the questionnaire of the students constitutes 10 items categorized under one theme. One sample t-test was employed to examine the effects of instructional strategies on mathematical discourse in high school. The findings are presented, analyzed and interpreted as follows: The results in Table 1 portray that there is no significant mean difference between the expected (3) and the observed (2.6) regarding the number of teaching experience. Similarly, table 1 shows that there is no significant difference between the expected (3) and the observed (3.1) regarding whether teachers' are aware of the respected curriculum or not. However, it is teachers' academic status which has a significant difference between the expected (3) and the observed (2.3)

The results in Table 2 portray that there is significant mean difference between the expected (3) and the observed (3.54) regarding the frequency of the discourse. Similarly, table 1 show that there is a significant difference between the expected (3) and the observed (3.38) regarding the contribution of a student to his or her group. Furthermore, there is a significant mean difference between the expected (3) and the observed (2.3) regarding exercising mathematics outside the classroom. The interviewees' written work and researcher's notes during the interview sessions were taken into considerations. Data were categorized according to themes and analyzed for each subject. Finally, the analyses across the subjects were carried out for each theme for the purpose of identifying emerging patterns of thought. Responses to some items in the questionnaire were directly recorded and summarized to calculate the frequencies and percentages of participants' choices for each category. From the findings, school administrators perceived that Mathematics teachers played a substantial function in the effectiveness of Mathematics teaching. Teachers demanded to be well-qualified and well-educated in approaches of teaching Mathematics in order to be efficient. Put differently, they need to be specialist Mathematics teachers who are keen about Mathematics, and are ready and willing to accommodate their teaching practices and take on new approaches to teaching Mathematics in order to provide for learners' individual demands. To do this, the teachers conceived that they have a need for professional development in order to amend classroom practices. Furthermore, the teachers also needed endorse and high degrees of professional community and accountability not only within the Mathematics department, but also from other departments as well. A culture of openness and collegiality among teachers of Mathematics is also looked for, in order to modify them to gain more teaching experience and Mathematics resources while also minimizing errors in their teaching instructions. This result is coherent with that of Anthony and Walshaw (2007) who discovered that, outside the classroom, the straightaway professional community has a branded result on teachers' effectiveness.

Conclusion

It is not easy to teach mathematics effectively, and it has become more challenging for Ethiopian teachers in recent years. In addition, this study has created a situation where all students must find their way quickly around the complexities of learning mathematics, regardless of the various factors that can affect their learning of the knowledge and skills implicit within it. One factor in this process that the classroom teacher can control is the quality of instruction. As educators, we owe

it to our students to make the most of this factor. Furthermore, the researcher recommends that additional research has to be conducted on specific strategies such as cooperative learning and problem-solving approaches.

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