

The Role of Self-Efficacy in Dialogue and Argumentation for Enhanced Academic Performance of Ordinary Level Mathematics Students in Zimbabwe

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ABSTRACT

The purpose of this study sought to determine the role of self-efficacy in dialogue and argumentation to improve students' academic performance in O' level Mathematics. The study employed a mixed methods approach to collect quantitative data using teachers' questionnaires and qualitative data using interviews with the participating Mathematics Heads of Departments. The subjects of this study consisted of 66 O' level Mathematics teachers who were randomly selected and 10 Mathematics Head of Department who were purposively selected at particular schools in Zimbabwe. Hypotheses were tested using the structural equation modelling approach that employed AMOS version 22. Thematic analysis was used in qualitative analytic procedures to process the interview. The empirical findings of the study established that that mathematical self-efficacy is both a catalyst and enabler for productive dialogic engagement and academic success in Mathematics. The findings of the study might not be generalised to other academic levels like or tertiary institutions since it was limited to the role of self-efficacy in dialogue and argumentation for enhanced academic performance of ordinary level mathematics students. Results of this study have implications for both policy and practice with regards to the teaching of ordinary level mathematics in Zimbabwe.

Keywords: Dialogue and argumentation, Mathematics achievement, Mathematics self-efficacy.

INTRODUCTION

Instructional methods employed by teachers constitute a critical factor influencing students' self-efficacy and academic performance in Mathematics (Richardson et al., 2015). In particular, the use of dialogue and argumentation in classroom practice has been found to enhance students' mathematical self-efficacy, which in turn positively affects their overall achievement.

The literature (e.g. Alrabi, 2018; Al-momani & Atoum, 2018; Dickson, 2018; Garon-Carrier, 2016; Makamure, 2018; Siew, 2018) indicates that many factors such as self-efficacy, attitude, motivation and instructional methods contribute to the poor performance in Mathematics. Numerous studies (e.g. Buibas & Stankous, 2015; Lin & Wu, 2016; Richardson et al., 2015; Siew, 2018) linked these problems to the teachers' instructional strategies as having a big impact on the students' attitudes and performance in Mathematics class.

Mathematical self-efficacy is a person's judgement of their capacity to solve particular mathematical problems (Al-momani & Atoum, 2018; Bonne & Lawes, 2016; Dullus, 2018; Yokoyama, 2019). This suggests that a student's level of mathematical self-efficacy affects how much effort they put forth and how long they are willing to stick with something when difficulty or failure arise. This is because it denotes engagement and a favourable view of the schoolwork, high self-efficacy is crucial in the development of the desire to learn Mathematics (Makamure, 2018). This means that poor mathematical self-efficacy in students often decreases their motivation to learn and may lead to low Mathematics achievement.

According to Bonne and Lawes (2016) Mathematics achievement and self-efficacy are positively correlated; as achievement increases, so does self-efficacy in the future, which is then linked to increases in subsequent

achievement. This implies that in learning Mathematics, there are many reasons related to how the performance of the students is affected such as teaching processes, strategies, students' motivations and assessments. Efforts are needed for promoting mathematical self-efficacy for high school students because it is positively associated with Mathematics achievement (Cordova & Tan, 2018). A study done by Al-momani and Atoum (2018) on self-efficacy and academic achievement among Jordanian students showed a significant effect of self-efficacy on academic achievement. These findings show that self-efficacy is an important factor in explaining Mathematics achievement. Thus, it is logical to assume that self-efficacious students perform better in various Mathematics tasks.

Low achievement in Mathematics may be due to classroom instruction methods that may prevent the development of students' Mathematical self-efficacy. Learning is known to be most effective when students are involved in discourse that enables them to reflect on their thinking while also engaging in cognitive restructuring of their own understanding and knowledge (Muhonen, 2018). Shared thinking or educational discourse is when individuals are receptive to one another's viewpoints and work to comprehend one another (Phillipson & Wegerif, 2017). The development of students' communication skills and capacity for conversation as well as the creation of shared knowledge among students through educational dialogue can have an impact on students' lifelong learning as well as the quality and significance of their lives (Groschner et al., 2015). Zimbabwe School Examination council (ZIMSEC) O' level Heritage-Based Pure Mathematics syllabus of 2024 to 2030 recommends the use of instructional methods that encourage classroom discourse and inquiry. Thus, it desires to produce a learner with the ability to communicate mathematical ideas and information effectively. By allowing students to share and discuss their ideas and insights with peers, student participation in classroom discourse improves the development of conceptual knowledge, mathematical vocabulary, communication skills, and problem-solving abilities (Alexander & Hardman, 2017). Thus, this leads to the development of student self-efficacy in Mathematics.

Argumentation and dialogue are important components of developing mathematically proficient students who construct viable arguments, critique the reasoning of others (Arista et al., 2018), and in the process develop self-efficacy in Mathematics. Self-efficacy has a direct effect on students' mathematical performance and interest (Makamure, 2018). According to Rapanta (2019), argumentation is a dialogue practice that stimulates and promotes students' critical thinking. It is a pathway to the development of critical thinking skills manifested in educational dialogue. Thus, this study sought to determine the role of self-efficacy in dialogue and argumentation to improve students' academic performance in O' level Mathematics. The following objective guide the study: Establish the extent to which dialogue and argumentation influences the academic performance of O' level Mathematics students.

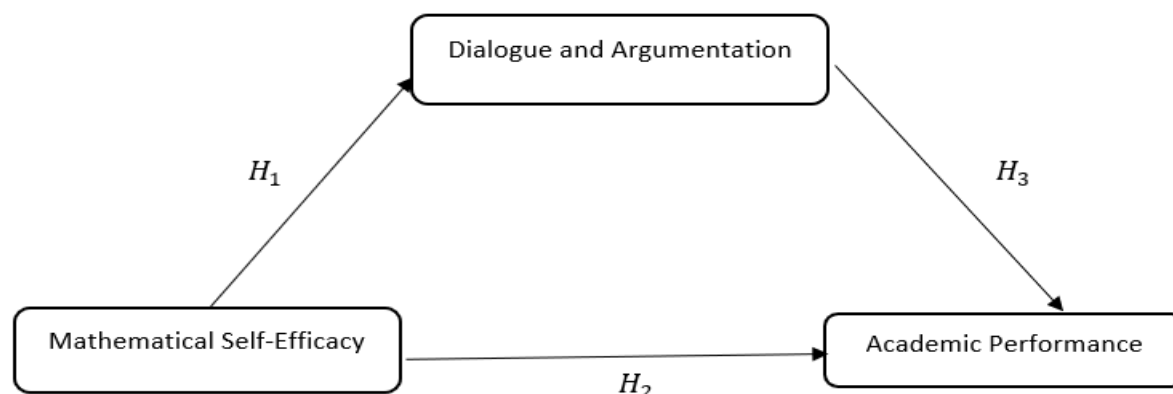
LITERATURE REVIEW: THEORETICAL AND CONCEPTUAL FRAMEWORK INFORMING HYPOTHESES FORMULATION.

This study is grounded in Social Cognitive Theory (Bandura, 1997), which posits that individuals actively shape their learning through cognitive, affective, and behavioural processes. A central element of this theory is self-efficacy, which is an individual's belief in their capability to achieve a specific goal or complete a task. According to Social Cognitive Theory:

- Self-efficacy plays a mediating role in learning and performance.
- Cognitive, affective, and behavioural factors interact in a triadic reciprocal causation model.
- Self-efficacy influences motivation, engagement in the learning of the learners.

In the context of this study, the focus is on how mathematical self-efficacy (MSE), as an internal psychological factor, interacts with pedagogical strategies such as dialogue and argumentation (DA), ultimately influencing academic performance (AP) among O' level Mathematics students. A research model (Figure 1) based on the Social Cognitive Theory (Bandura, 1997) to illustrate the relationships between mathematical self-efficacy, dialogue and argumentation, and academic performance in O' level Mathematics was developed.

Figure 1: Research Model: Mathematical constructs and Academic Performance.



Mathematical Self-Efficacy

At the heart of the model is Mathematical Self-Efficacy (MSE), which encompasses students' beliefs in their own ability to solve mathematical problems, persist through challenges, and understand complex concepts. Research consistently affirms that self-efficacy plays a critical role in students' learning outcomes and engagement. Separate studies by Prabawanto (2018) and Denisia and Jeyanthi (2015) found that students with higher levels of mathematical self-efficacy demonstrated more persistence, effort, and strategic thinking in their approach to mathematical problem-solving. Similarly, Marat (2017) described self-efficacy as a multidimensional construct influencing cognitive strategies, motivation, and emotional stability and these are factors essential for success in mathematics.

Mathematical Self-Efficacy and Effective Use of Dialogic and Argumentation

Students who possess strong beliefs in their mathematical capabilities are more likely to engage confidently in class discussions, justify their reasoning, and challenge ideas through argumentation. This aligns with the studies by Marat (2017), Denisia, and Jeyanthi (2015) that emphasized that students' affective, cognitive, and conative domains shape their willingness to communicate mathematical ideas and participate in collaborative reasoning. Based on the results of the previous research, the first hypothesis of this study is given as follows:

H₁: There is a significant and positive relationship between mathematical self-efficacy and effective use of Dialogic and argumentation in the teaching O' level Mathematics students.

Mathematical Self-Efficacy and Performance of Students.

Separate studies by Gupta and Kundu (2017), Odiri (2020), and Bartimore-Aufflick et al. (2016), found that students with higher self-efficacy tend to perform better in mathematics. This is attributed to the fact that self-efficacious students are more motivated, use effective problem-solving strategies, and demonstrate greater resilience in the face of challenges. In their review, Matt and Roslan (2019) concluded that mathematical self-efficacy is a consistent and reliable predictor of academic success, especially among secondary school students. Based on the results of the previous research, the second hypothesis of this study is given as follows:

H₂: There is a significant and positive relationship between mathematical self-efficacy and academic performance of students.

Dialogue and Argumentation, and Academic Performance of Students.

Classroom interactions that promote critical discussion and collaborative reasoning have been shown to deepen conceptual understanding and improve retention of mathematical knowledge. Research by Pagtulon-An and Tan (2018) found that students exposed to rich assessment tasks, many of which required dialogue and reasoning, performed significantly better than their peers who were not exposed to such learning environments.

Similarly, study by Balimuttajjo et al. (2021) showed that instructional approaches encouraging mathematical reasoning and discussion improved both self-efficacy and academic achievement. Based on the results of previous research, the third hypothesis of this study is given below:

H₃: There is a significant and positive relationship between dialogue and argumentation and academic performance of students.

RESEARCH METHODOLOGY

Pragmatism research paradigm was used to guide knowledge production in the study. The study employed a mixed methods approach. The concurrent triangulation (parallel) that employs a design research was used to collect qualitative and quantitative data. Quantitative data was collected using teachers' questionnaires and qualitative data was collected using interviews with the participating Mathematics Heads of Departments (HODs). The research strategy used was a case study. The subjects of this study consisted of a 66 O' level Mathematics teachers and 10 Mathematics Head of Department (HODs) at particular schools in Gutu district of Masvingo province in Zimbabwe. Purposive or Judgmental (non-probability) sampling was used by the researcher to choose ten participating Mathematics Head of Departments (HOD) of this study. The purposive sampling technique is the deliberate choice of participant due to the qualities the participant possesses (Alkassim et al., 2016). Random sampling technique (probability sampling) was used to select a sample of participating teachers from each school. The researcher acquired a research permit from the Ministry of Primary and Secondary Education (MOPSE) of Zimbabwe before commencing data collection. Informed consent for participants was also obtained. The biographic factors of the Mathematics teachers who participated in the study are shown in Table 1 below.

Table 1: Biographic factors of O' level Mathematics teachers

Factor	Item	Number	%
Gender	Female	27	41
	Male	39	59
Age	<30 years	15	23
	31-40 years	26	39
	41-50 years	13	20
	> 50 years	12	18
Educational level	Certificate in Education (CE)	4	6
	Diploma in Education (Dip Ed)	15	23
	Bachelors degree	35	53
	Master's degree	12	18
Years of teaching experience	≤10 years	21	32
	11-20 years	18	27
	21-30 years	16	24
	> 30 years	11	17

The results in table 1 showed that schools have more male (59%) than female teachers teaching O' level Mathematics. Most of the teachers teaching Mathematics at Ordinary level have an undergraduate degree which very few (29% being non-degreed). It is also shown from table 1 that most of the teachers have 20 years

and below years of teaching experience which also corresponds with the fact that most (52%) of teachers are below 40 years of age. Table 2 below display the Mathematics Head of Departments' biographical profiles.

Table 2: Biographic Factors for Mathematics HODs

Factor	Item	Number	%
Gender	Male	6	60
	Female	4	40
Age	<30 years	0	0
	31-40 years	3	30
	41-50 years	4	40
	> 50 years	3	30
Educational level	Certificate in Education (CE)	1	10
	Diploma in Education (Dip Ed)	3	30
	Bachelors degree	4	40
	Master's degree	2	20
Years of teaching experience	≤10 years	0	0
	11-20 years	6	60
	21-30 years	3	30
	> 30 years	1	10

The results in Table 2 show that most of the Mathematics HODs are male (60%) and few are female. The results in Table 2 also show that most of the teachers are 50 years or below (70%) and out of these 70%, 40% are aged between 41 and 50 years, that is, are middle aged. It is also shown in Table 2 that most of the HODs (60%) are degree holders with 40% of these HODs being bachelor's degree holders. This shows that most of the HODs have taken the root of upgrading themselves from just being Certificate in Education holders. The results in Table 2 further show that most of the HODs (60%) have between 11 and 20 years of teaching experience and this should be adequate for them to be able to effectively lead their departments.

Instrument development

A structured questionnaire with eight items that used a five-point Likert scale was developed for collecting data on the role of self-efficacy in dialogue and argumentation for enhanced academic performance of ordinary level mathematics students. The eight items were as follows: 1. Mathematical self-efficacy beliefs provide a solid foundation for promoting student motivation during dialogue and argumentation. 2. Mathematical self-efficacy beliefs provide a solid foundation for promoting student risk-taking during dialogue and argumentation. 3. Mathematical self-efficacy beliefs provide a solid foundation for lowering students' levels of anxiety during dialogue and argumentation. 4. Mathematical self-efficacy beliefs provide a solid foundation for promoting student self-assertiveness. 5. Mathematical self-efficacy beliefs provide a solid foundation for promoting more student persistence during dialogue and argumentation. 6. Mathematical self-efficacy beliefs provide a solid foundation for promoting more student initiative taking during dialogue and argumentation. 7. Mathematical self-efficacy beliefs provide a solid foundation for helping students to apply more effort during dialogue and argumentation. 8. Mathematical self-efficacy beliefs provide a solid foundation for enhances student academic performance. Semi-structured interview guide was used to collect qualitative data from the participating Mathematics Heads of Departments (HODs). Interviews provide the

chance to obtain information that cannot be obtained through observation and to cover any gaps or omissions in questionnaires (Kanika, 2015). Interviews provided an in-depth look at the beliefs, perceptions and experiences of the participating Mathematics Heads of Departments (HODs) on their experiences on the role of self-efficacy in dialogue and argumentation for enhanced academic performance of ordinary level mathematics students.

RESULTS

This section discusses data validation for the measurement scale as well as how data were analysed.

Validation of the Research Instrument

To establish the reliability of the data, internal consistency reliability was measured using both Cronbach's alpha and composite reliability metrics. The values of Cronbach's alpha as well as of the composite reliability were between .768 and .920 and are above .7 thereby satisfying the benchmark value of $\alpha \geq .7$ for internal consistency reliability (Hair et al., 2010; Howell et al., 2010). Internal consistency reliability is therefore confirmed.

With regards to establishing convergence validity, standardized factor loadings, Cronbach's alpha, composite reliability, and Average variance extracted were used (Hair et al., 2017). Standardized factor loadings ranged between .639 and .933 thus falling within the benchmark of $SFL > .6$ (Hair et al., 2010), Cronbach's alpha and composite reliability values ranged between .768 and .901 hence falling within the benchmark of $\alpha \geq .7$ (Howell et al., 2010), and Average variance extracted values ranged between .650 and .733 thereby falling within the benchmark of $AVE > .6$. Since all the benchmarks for each metric used to measure convergence validity were satisfied, convergence validity was thus achieved (Hair et al., 2014; 2019).

Trustworthiness criteria was established for the semi-structured interview guide. One major aim of the research was to put the knowledge created into practice. As a result researchers, practitioners, policymakers, and the general public must understand and accept the findings as legitimate. Trustworthiness criteria are one-way researchers can convince themselves and readers that their study findings are worthy of attention (Nowell, Norris, White, & Moules, 2017). The criteria established were confirmability, dependability, transferability, and credibility.

In qualitative research, confirmability is a crucial criterion for establishing the trustworthiness of the study. It refers to the degree to which the researcher's biases are minimized and the findings accurately reflect the participants' perspectives and experiences (Lincoln & Guba, 1985). Techniques such as member checking and maintaining an audit trail are commonly used to enhance confirmability (Creswell, 2013). The researcher guaranteed confirmability by preventing his knowledge, values, and conclusions from impacting the study's findings. Each phase of the data analysis was included in the study, including the conclusions that were derived as suggested by Charmaz and Kusi (2012)

Dependability is a critical aspect of qualitative research, emphasizing the need for consistency and traceability in the research process (Lincoln & Guba, 1985). By maintaining an audit trail and providing clear documentation of research procedures, researchers enhance the dependability of their study (Creswell, 2013). To increase the dependability of the study findings, the researcher asked clear questions throughout the data collection, minimized bias, and controlled objectivity.

Transferability is a key consideration in qualitative research, focusing on the applicability of the study's findings to other contexts (Lincoln & Guba, 1985). By providing rich and detailed descriptions of the research context and participants, researchers enhance the transferability of their findings, enabling readers to assess the relevance to their situations (Creswell, 2013).

Credibility is a cornerstone of ensuring the trustworthiness of the study. It focuses on demonstrating the rigor of the research process and the soundness of the interpretations drawn from the data (Horsman, 2018).

Techniques such as prolonged engagement, triangulation, and member checking contribute to enhancing the credibility of the study's findings (Creswell, 2013).

Data Analysis and Integration

This section tests the hypotheses which were formulated based on the relationships between variables established in the study. It also marks the stage when quantitative and qualitative data are integrated. Hypotheses were tested using the structural equation modelling (SEM) approach that employed AMOS version 22. Before the hypotheses testing could be conducted using SEM, model fit metrics analysis was done to establish whether the metrics were within the acceptable levels model fit for structural equation modelling to be conducted. The model fit metrics also called the modified measurement assessment indices, which were analysed, were

1. the absolute fit metrics namely, the Chi-square value/degree of freedom (χ^2 /df), goodness of fit index (GFI) and adjusted goodness of fit index (AGFI),
2. (ii) the incremental fit metrics namely, normed fit indices (NFI), and the Tucker Lewis index (TLI) also called the Non-normed fit index (NNFI), and
3. the parsimonious fit metrics namely, the comparative fit index (CFI), and the Root mean square error of approximation (RMSEA).

For measurement model fit to be deemed acceptable, the measurement metrics should satisfy the following benchmarks: $\chi^2 /df < 3.000$; $TLI > .9000$; $NFI > .9000$; $GFI > .9000$; and $AGFI > .9000$; and $.0600 \leq RMSEA \leq .0800$. The results of the measurement model assessment shows that all the modified model measurement were above the minimum recommended values ($\chi^2 /df = 2.377$; $GFI = .963$; $AGFI = .972$; $NFI = .968$; $TLI = .981$; $CFI = .933$; and $RMSEA = .047$) hence demonstrated all the fit indices were of acceptable levels hence path analysis using structural equation modelling was performed to test hypotheses.

Table 4: Path analysis on hypothesized relationships

Hypotheses	DV	Path	IV	Unstandardized estimates	SE	P	Standardized estimates	R ²
H_1	DA	←	MSE	.314	.061	.001	.581	.429
H_2	AP	←	MSE	.408	.033	.000	.647	.513
H_3	AP	←	DA	.439	.059	.000	.413	.609

Key: DV - Dependent variable; IV - Independent variable; SE - Standard error; P - significant level; R² Coefficient of determination; Significant level - .05

The results in Table 4 show that Mathematical Self-Efficacy (MSE) has a significant and positive influence on the effectiveness of dialogue and argumentation in the teaching of O' level Mathematics ($\beta = .581$; $p = .001$; $p < .05$). The quantitative results were also supported by qualitative results from interviews with HODs. Thematic analysis was used in qualitative analytic procedures to process the interview data. The results of the quantitative data was also confirmed in the interview results with HODs who argued that once students develop a feeling that they have both the confidence and ability to solve mathematical problems, they can learn effectively using dialogue and argumentation. Sub-themes that came out of the interviews with HODs on the influence of mathematical self-efficacy on the effective use of dialogue and argumentation include confidence, ability, competence, knowledge sharing, and enhanced understanding. In fact, most of the HOD interviewed suggested that collective teaching enables teachers and students to more effectively address learning task together, whether as a group or as a class rather than in isolation. They also suggested that students share information, develop joint understanding, critically evaluate ideas and find creative solutions to mathematical problems. Most of the HODs interviewed further suggested that mathematical self-efficacy influences the implementation of dialogue and argumentation in the teaching of O-level Mathematics approach by enabling the teachers to orchestrate whole class discussion collecting ideas from everyone. The HODs suggested that this strategy enhances collective and shared instructional and pedagogical activities in the classroom. Most of

the HODs posited that mathematical self-efficacy enables the teacher to facilitate student-student interaction and support students in challenging and contributing to one another's ideas. They also argued that mathematical self-efficacy enables the teachers to give every student a chance to contribute to discussions. Among some of the non-verbatim responses the HODs gave with regards to the role of mathematical self-efficacy in the effective application of dialogue and argumentation were the following:

HOD 01 suggested that mathematical self-efficacy provides opportunities for students to agree or disagree, challenge, question, appeal to reason and allowing self-correction as they seek to understand a given concept and solve a given problem in Mathematics. The HOD also argued that mathematical self-efficacy enables teachers to promote active students' participation in the Mathematics lessons.

HOD 05 posited that mathematical self-efficacy allows students to listen to each other, confidently explain mathematical ideas or concepts to each other, instruct each other, explore and evaluate mathematical ideas, analyse and solve mathematical problems. The HOD argued that without dialogue and argumentation between the teachers and the students and between students teaching and learning in Mathematics is impaired. The HOD also argued that mathematical self-efficacy during dialogue and argumentation develops confidence in students and also helps the students to discover or challenge mathematical misconceptions, build new concepts where no current concept exist and aid students with problem solving.

HOD 07 argued that mathematical self-efficacy enhances the contribution of students in addressing learning task during mathematical dialogue and argumentation. HOD 07 further posited that mathematical self-efficacy provides opportunities for teachers to encourage their students to reflect on their ideas as a means of better understanding them.

It is further shown in Table 4 that mathematical self-efficacy has a significant influence on the academic performance of O' level Mathematics students ($\beta = .647$; $p = .000$; $p < .05$; $R^2 = .513$). The results in table 4 show that mathematical self-efficacy contributes 51.3% variation to the effective use of dialogue and argumentation in the teaching of O' level Mathematics as well as to the academic performance of the students. These results are also confirmed in the interview results that show that once students believe that they are confident and able enough to solve mathematical problems using the dialogue and argumentation approach, they tend to demonstrate enhanced academic performance. The interview results with HODs generated the following sub-themes on the influence of mathematical self-efficacy on effective implementation of dialogue and mathematical self-efficacy: confidence, ability levels, enhanced academic performance, and motivation. Among some of the responses of HODs on the influence of mathematical self-efficacy on the effective implementation of dialogue and argumentation in the teaching of O' level Mathematics include the following:

HOD 01 suggested that students with high levels of self-confidence and self-efficacy tend to experience lower levels of stress and direct their energy toward dialogue and argumentation. HOD 01 further suggested that efficacious students study for longer periods and demonstrate better engagement behaviour on the task, which includes persistence and perseverance with task.

Similarly, HOD 05 suggested that self-efficacy influences students' higher order thinking skills and ability to persevere and deal with challenging tasks. HOD 05 further suggested that self-efficacy improves students' engagement in mathematical tasks which in turn stimulates their willingness and preparedness to explore further mathematical concepts and ideas through dialogue and argumentation approach. HOD 05 also suggested that self-efficacy boost the students' confidence levels and expectancies for success as well as the subjective value ascribed to the mathematical task thereby enhancing their ability to apply dialogue and argumentation approach in the learning of Mathematics.

HOD 08 also suggested that students with high mathematical self-efficacy have greater persistence levels on difficult mathematical concepts than students with low self-efficacy. HOD 08 further posited that mathematical self-efficacy has an influence on students' confidence in mathematical problem solving skills which in turn contributes to enhanced problem-solving competences. HOD 08 also suggested that mathematical self-efficacy enhances students' ability to respond effectively to stressful and challenging mathematical tasks. HOD 08 argued that students with strong and positive efficacy beliefs about their learning

ability are more like to take risks and use new techniques to solve mathematical tasks leading to improved use of dialogue and argumentation.

Finally, the results in Table 4 show that the dialogue and argumentation approach has a significant and positive influence on the academic performance of O' level Mathematics students ($\beta = .413$; $p = .000$; $p < .05$; $R^2 = .609$). The results in Table 4 show that dialogue and argumentation contributes 60.9% variation to the academic performance of O' level Mathematics students. The results further show that the model as a whole explains 62.5% variation to the academic performance of students due to the application of dialogue and argumentation. Interview results with HODs confirm the above results. The interview results with the HODs also generated the following sub-themes: conceptual understanding, improved academic achievement, problem-solving skills, critical thinking skills, and effective learning. In fact, most of the HODs interviewed suggested that when students are taught how to use language in an effective way in collaborative activities, their participation in the use of dialogue and argumentation increases and so does their academic achievements in Mathematics.

Most of the HODs were of the view that dialogue and argumentation ensures students' effective interaction in the learning of Mathematics which in turn enhances mathematical understanding and problem solving, contributing to the improvement in academic performance. In addition, most of the HODs interviewed suggested that students' participation in Mathematics through the use of dialogue and argumentation increases their self-confidence, self-efficacy, and positive attitudes towards Mathematics leading to improved academic performance. Further, most of the HODs suggested that the dialogue and argumentation approach allows students to engage in collaborative, enthusiastic, and productive ways of learning leading to higher levels of attainment in Mathematics. Among some of the non-verbatim responses by HODs on the influence dialogue and argumentation on the academic performance of O' level Mathematics students, the following were some of them:

HOD 01 for example, suggested that dialogue and argumentation ensures that students have the same opportunities to participate in their learning and provide their own ideas and opinions. HOD 01 argued through dialogue and argumentation, students are encouraged to develop argumentation and reasoning skills than enable them to effectively question and counter-argue classmates' responses leading to better understanding of concepts and enhanced academic performance in Mathematics.

HOD 05 argued that dialogue and argumentation allows teachers to establish a learning environment in which students and teachers work collaboratively in exploring solutions to mathematical problems. HOD 05 further suggested that dialogue and argumentation allows transformative listening in which teachers listen to students' contributions in a manner that conveys that there is a genuine meeting of minds and that the teacher is genuinely willing to assist students to improve both their thinking and performance in Mathematics.

Finally, HOD 10 also argued that the dialogue and argumentation approach provides students with opportunities to positively react to other students' ideas, add detail to given solutions, qualify general statements and also find flows in others' arguments in order to improve them. This, according to HOD 10, helps students to understand mathematical concepts better and ultimately, perform better academically.

Overall, the results show that mathematical self-efficacy not only has a direct significant influence on academic performance but also an indirect significant influence through its effect on students' engagement in dialogue and argumentation.

DISCUSSION

This section discusses the influence of mathematical self-efficacy (MSE) on O' level students during the use of the dialogue and argumentation approach in the Mathematics classroom. It emerged in the study that Mathematical Self-Efficacy (MSE) has a significant and positive influence on the application of dialogue and argumentation as well as academic performance of O' level Mathematics students. This suggests that students with high self-efficacy capabilities demonstrated abilities in solving difficult tasks, being more initiative, being

more risk taking, being more persistent, having ambition, actively participate in Mathematics lesson and perform better academically.

This is confirmed in the findings of the previous studies. A study by Arifin et al. (2021) showed that students with high mathematical self-efficacy solved mathematical problems more accurately and efficiently than students with low mathematical self-efficacy. The results of Arifin et al. (2021)'s study further showed that differing academic levels in mathematical self-efficacy (MSE) leads to different academic levels in Mathematics.

In yet another study by Bartimore-Aufflick et al. (2016) it was found that students with positive mathematical self-efficacy put more effort in their work and always will try unfamiliar tasks when compared to their counterparts. In contrast, an individual with a low sense of self-efficacy will put less effort and surrender when carrying out new tasks (Bartimore-Aufflick et al., 2016). This is consistent with the findings of a study by Dullus (2018) that showed that as academic self-efficacy of student increases, their academic performance also increases. Thus, self-efficacy is a good measure of students' academic performance.

To further demonstrate the critical role of mathematical self-efficacy (MSE), the studies by Alrabi (2018) and Prabawanto (2018) found that there was a significant relationship of self-efficacy and various learning variables such as motivation, behaviour and academic performance. Students with higher mathematical self-efficacy (MSE) were more persistent when faced with difficult mathematical problems when compared with students with lower mathematical self-efficacy (MSE). This is also in line with the results of studies by Odiri (2020) and Siswanti and Djalal (2017) which showed that students with higher levels of self-efficacy are more persistent, set higher learning goals, apply more effort and are more likely to use self-regulated learning strategies in the learning of Mathematics.

This section discusses the influence of the dialogue and argumentation approach on the academic performance of O' level Mathematics students. It emerged from the study that the dialogue and argumentation approach has a significant and positive influence on the academic performance of O' level Mathematics students. The results of the study showed that when students are taught how to use language during the use of dialogue and argumentation in the Mathematics classroom in an effective way in collaborative activities, their participation in the use of dialogue and argumentation increases and so does their academic achievement in Mathematics. This suggests that students' talk in collaborative interaction with others during the use of the dialogue and argumentation approach in the Mathematics classroom is the key to learning and enhance their academic performance.

The above results are confirmed in the findings of the previous studies. A study by Alexander (2017) found that dialogue and argumentation provides students with opportunities to use mathematical language to engage in shared meaning making towards common learning goals in the Mathematics classroom. This suggests that the use of mathematical language during the use of the dialogue and argumentation approach plays the critical role in the learning and performance of students in the Mathematics classroom.

Studies by Alexander and Hardman (2017), Musa (2019) and Cabanas-Barraza et al. (2019) demonstrated the positive influence of dialogue and argumentation on the academic performance of students in Mathematics. The findings of all the studies indicate that dialogue and argumentation gives students the chance to become highly proficient in Mathematics by enabling them to write and speak in the language of Mathematics. This improves student performance and engagement in the subject matter.

It was also established that the dialogue and argumentation approach ensures students' effective interaction and participation in the learning of Mathematics to enhance mathematical understanding and problem solving, contributing to the improvement in academic performance. This suggests that students need support and scaffolding in their interaction in the classroom in order to explore their thinking and understanding. Thus, the teacher has a vital role in facilitating and creating effective learning experiences for students.

The above results are consistent with the results of the past. A study by Alexander (2017) showed that dialogue and argumentation allows students to adopt active roles by participating in meaningful activities and sharing

their thoughts. This suggests that students' effective interaction in the learning of mathematics contributes to the improvement in their academic performance.

Studies by Telenius et al. (2020), Alexander and Hardman (2017) found that students' participation in Mathematics using dialogue and argumentation increases their self-confidence, self-efficacy, and attitude towards Mathematics, leading to improved academic performance. This shows that teaching students through dialogue and argumentation is beneficial in lowering their mathematical anxiety as well as improving their success in studying Mathematics. The results are also in accord with the study by Esmaeilli et al. (2018) which supported the positive impacts of the dialogic learning on improving the students' mathematical knowledge, attitudes and skills. This suggests that the use of dialogue and argumentation in the mathematics classroom generates better learning outcomes and this may enhance self-efficacy in the learning of Mathematics.

It is further shown in the study that the dialogue and argumentation approach allows students to engage and participate in collaborative, enthusiastic, and productive ways of learning that lead to higher levels of attainment in Mathematics. This suggests that dialogue and argumentation provides students the opportunities to participate in their learning and provide their own ideas and opinions.

A number of past studies confirm the above results. A study by Daryn (2018) found that dialogue and argumentation provides the teacher and students with the opportunities to bring their own views to the Mathematics discussions, identifying different points of view and related questions. Another study by Hennessy et al. (2019) discovered that higher academic performance of students in Mathematics was positively correlated with high levels of student participation during the use of dialogue and argumentation, where students are actively engaging with others' ideas, in conjunction with high levels of elaboration (or building on ideas) and querying (or challenging).

Studies by Cabanas-Sanchez et al. (2019), Sanchez et al. (2019), Potari and Psycharis (2018) and Acar (2015) found that through dialogue and argumentation, students are encouraged to develop argumentation and reasoning skills that enable them to effectively question and counter-argue classmates' responses leading to better understanding of concepts and enhanced academic performance in Mathematics. This suggests that dialogue and argumentation teaching promotes enquiry and reasoning, encourage thinking and move learning forward. This shows that the dialogue and argumentation approach enhanced the performance of students.

It further emerged from the study that dialogue and argumentation helps the students to understand mathematical concepts better as it allows teachers to listen to students' contributions and assist students to improve both their thinking and performance in Mathematics. This suggests that the use of the dialogue and argumentation approach in the Mathematics classroom enables the teacher to empower the students in the learning of Mathematics to reach and justify mathematical conclusions based on their own mathematical knowledge without relying on the authority of the teacher.

The above results are consistent with earlier studies. A study by Cabanas-Sanchez et al. (2019) found that exchanges of opposing views, grounds and supporting reasoning as allowed for by the dialogue and argumentation approach gives the students the opportunity to examine their own conjectures, thoughts, and understandings, and thus emphasises cognitive and metacognitive processes. Another study by Comek et al. (2015) discovered that the dialogue and argumentation approach improves students' conceptual understanding, fosters conceptual change and improvement in the learning environment, and gives students the capacity to comprehend how their mathematical knowledge is structured and evaluated. Further study by Gencoglan and Ural (2020) found that the dialogue and argumentation approach provides students with the opportunities to develop mathematical discussions and argument constructing skills to facilitate the students' understanding of the Mathematics concepts and increases their learning.

CONCLUSION

The study established a significant and positive influence of Mathematical Self-Efficacy (MSE) on the effective use of dialogue and argumentation in the teaching and learning of O' Level Mathematics. Quantitative results revealed that MSE contributes substantially to the effectiveness of dialogic teaching, while

also explaining a significant portion of variation in academic performance. Interview responses from Heads of Departments (HODs) confirmed these findings, highlighting key sub-themes such as confidence, competence, collaborative learning, and conceptual understanding.

Furthermore, dialogue and argumentation were found to contribute significantly to students' academic performance, indicating that when students are confident in their mathematical abilities, they are more likely to engage in productive peer discussions, share ideas, challenge misconceptions, and apply reasoning strategies, ultimately leading to improved outcomes. The triangulation of both quantitative and qualitative data underscores that MSE is both a catalyst and enabler for productive dialogic engagement and academic success in Mathematics.

RECOMMENDATIONS

To improve academic outcomes in mathematics, it is essential to adopt strategies that enhance students' mathematical self-efficacy. Teachers play a crucial role in this regard by incorporating approaches such as scaffolding, peer tutoring, mastery experiences, and the consistent use of positive feedback. The strategies help students build confidence in their mathematical abilities and develop a stronger sense of competence when engaging with complex mathematical tasks.

Furthermore, mathematics instruction should be intentionally structured to integrate dialogue and argumentation into everyday teaching practices. This includes encouraging collaborative problem-solving, organizing structured classroom debates, and facilitating whole-class discussions. Such practices not only stimulate learners' reasoning and critical thinking but also foster deeper conceptual understanding.

Equally important is the professional development of teachers. Training programmes should be designed to equip teachers with practical strategies for implementing dialogic pedagogy and cultivating self-efficacy among learners. These programmes should empower teachers to create inclusive, interactive classrooms where student voice and active participation are prioritized.

In addition, schools should strive to create collaborative learning environments. This involves adopting group-based, inquiry-driven teaching models that encourage both student-student and teacher-student interactions. By promoting cooperative learning, students are more likely to engage meaningfully with mathematical content and with each other, leading to improved learning outcomes.

Finally, the effective use of formative assessment is vital in building student confidence. Assessments should not solely focus on outcomes but rather on the learning process, emphasizing effort, progress, and individual growth. When students perceive assessment as a supportive tool rather than a judgment, they are more likely to persevere, take academic risks, and develop the resilience needed to succeed in mathematics.

Implications of the Study

The findings of this study carry several important implications across theoretical, practical, policy, and learner development domains.

From a theoretical perspective, the study offers strong support for Bandura's self-efficacy theory, illustrating that students' confidence in their mathematical capabilities significantly influences their willingness to engage in complex cognitive tasks such as dialogue, argumentation, and problem solving. By showing, that belief in one's ability directly affects participation in such higher-order thinking processes, the study deepens our understanding of how self-efficacy functions within the learning environment. Additionally, the study contributes to the growing body of literature on constructivist learning and dialogic teaching, particularly within the context of STEM education, where learner interaction and conceptual negotiation are key to understanding.

In terms of practical implications for teachers and schools, the research underscores the value of integrating mathematical self-efficacy, enhancing practices alongside dialogic and argumentation strategies in the classroom. These pedagogical approaches lead to marked improvements in student engagement and academic achievement. As a result, schools should prioritize learner-centred instruction and create environments that actively support students in expressing their ideas, collaborating with peers, and challenging their own thinking. Equally, teacher professional development must be strengthened to ensure that teachers are equipped with the skills and strategies needed to implement such practices effectively.

The study also presents key policy implications. It calls for curriculum planners and education ministries to formally incorporate dialogue and argumentation strategies into national mathematics curricula and teacher education programmes. Recognizing the value of these approaches at the policy level will ensure that they are not treated as optional enhancements, but as essential components of effective mathematics teaching and learning.

Finally, the research highlights critical implications for learner development. Beyond improving academic performance, fostering mathematical self-efficacy equips students with essential 21st-century skills such as reasoning, collaboration, problem solving, and perseverance. These competencies are fundamental not only for success in mathematics but also for lifelong learning and adaptability in an increasingly complex and dynamic world.

STUDY LIMITATIONS

Despite its valuable findings, this study is subject to several limitations that should be acknowledged when interpreting the results.

Firstly, the scope of the study was limited to role of self-efficacy in dialogue and argumentation for enhanced academic performance of ordinary level mathematics students. As such, the findings may not be easily generalized to other educational levels, such as primary or tertiary institutions, or to other subjects beyond mathematics. Broader studies encompassing diverse contexts may be necessary to confirm the applicability of these results elsewhere.

Secondly, the qualitative data collected through interviews with Heads of Departments (HODs) were based on non-verbatim responses. While these provided rich and insightful perspectives, the lack of direct quotations introduces the possibility of interpretation bias. The subjective nature of the data may affect both accuracy and replicability, as researchers' interpretations could influence how the responses are represented.

Thirdly, another limitation arises from the potential for self-report bias. Data from interviews depend on participants' self-perceptions and willingness to respond honestly. Responses related to confidence, motivation, and performance may have been influenced by social desirability, leading some participants to overstate positive attributes or underreport challenges.

Lastly, the study did not extensively account for contextual variables that may affect the relationship between mathematical self-efficacy (MSE) and academic performance. Factors such as class size, teacher experience, instructional quality, and availability of resources could significantly shape how MSE influences learning. A more comprehensive investigation into these contextual influences would enhance the depth and reliability of the findings.

These limitations highlight the need for further research with more diverse samples, and greater consideration of contextual factors to build on and validate the current study's conclusions.

Ethics Statement

An ethics clearance certificate was obtained from the Institutional Research Committee Ethical Clearance-Approval Number: BUSEREC/0031/2024 of the Bindura University of Science Education (BUSE) which reviewed all the research processes.

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No potential conflict of interest was reported by the author.

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