International Journal of Management and Humanities (IJMH)
ISSN: 2394-0913 (Online), Volume-11 Issue-1, September 2024

Assessing Implementation of Strengthening Mathematics and Science in Secondary Education (SMASSE): In the Case of Selected Secondary School of Kellem Wollega Zone, Oromia Regional State, Ethiopia

Tarekegn Dinku Gelu, Yohannis Alemayehu Wakjira

Abstract: ***This study aimed to identify the methods teachers use to integrate science and mathematics. These factors affect the implementation of integrated science and mathematics education and students' attitudes toward this integration in secondary schools in the Kellem Wollega zone of Ethiopia. Both open-ended and closed-ended questionnaires, along with structured interviews, were designed for the selected sample population. This targeted population was chosen from five different sites within the zone, comprising a total of 506 samples, of which 392 were students and 114 were teachers and school principals. The study found that teachers integrate science and mathematics using the PDSI approach, the ASEI approach, a student-centered approach, and generally the SMASSE approach. They employ various strategies, including assigning projects, conducting practical work with students, providing assignments and worksheets, and fostering team spirit among students. Several factors hindering the implementation of SMASSE in the study area were identified, including the teacher-student ratio, the disproportion between class size and the number of students, students' attitudes toward science and mathematics, a lack of laboratory facilities and equipment, an absence of a planned schedule, insufficient access to computers, inadequate assessment practices, a lack of sufficient time to complete the curriculum, and an inadequate quality assurance system. On the other hand, students exhibited a negative attitude toward the integration of science and mathematics education, which was influenced by factors such as their perceptions of mathematics, student-teacher interactions, feedback from teachers, teaching methods, course content, teachers' competencies, school management, and limited student participation in the classroom.***

Keywords: SMASSE, Teaching Methodology, Student Attitude

Manuscript received on 20 August 2024 | Revised Manuscript received on 06 September 2024 | Manuscript Accepted on 15 September 2024 | Manuscript published on 30 September 2024.
***Correspondence Author(s)**

Tarekegn Dinku Gelu*, Department of Mathematics, College of Natural and Computational Science, Dambi Dollo University, Ethiopia. E-mail: tarekegn.d13@gmail.com, ORCD ID: 0000-0002-4169-8244

Yohannis Alemayehu Wakjira, Department of Mathematics, College of Natural and Computational Science, Dambi Dollo University, Ethiopia. E-mail: Yohannes@gmail.com

I. INTRODUCTION

There are numerous benefits associated with integrated education. Research indicates that an interdisciplinary or integrated curriculum offers learners more relevant, cohesive, and stimulating experiences (Furner & Kumar, 2007, [1]). Additional advantages include a student-centered approach, enhanced higher-level thinking skills, improved problem-solving abilities, and better retention of information (Fllis & Fouts, 2001, [2]).

The studies agree that a positive attitude towards mathematics among students leads to improved performance in examinations. Other international research has noted similar findings. For instance, a study conducted by (Shahid 2008, [3]) on students' attitudes towards mathematics in Pakistan revealed that a positive attitude positively affects students' achievement in the subject. The study observed that how mathematics is represented in the classroom and perceived by students can alienate many learners from the content, even when teachers believe they are presenting it in an authentic and context-dependent way.

There is a limited amount of research examining the prerequisite skills, beliefs, knowledge bases, and experiences necessary for teachers to implement integrated instruction (Fykholm & Glasson, 2005, [4]). This statement is particularly relevant for strengthening mathematics and science education, as it is still relatively new. The national science board (NSB) emphasized the importance of focusing on what teachers need to effectively teach integrated mathematics and science education in their document, national action plan for addressing the critical needs of the national science, technology, engineering, and mathematics education system. NSB states in this document that well-qualified and highly effective teachers should be responsible for teaching integrated mathematics and science classes. They call for increased national attention on attracting, preparing, and retaining qualified and committed teaching candidates (NSB, 2007). However, the best strategies for attracting, preparing, and retaining qualified teachers remain to be determined. Reason: improved clarity, corrected grammatical errors, enhanced vocabulary, and ensured technical accuracy.

Similar benefits have been identified with a more specific focus on integrated smase education. Several advantages of SMASSE education include enhancing students' problem-solving abilities, fostering innovation and invention, promoting self-reliance, developing logical thinking skills, and improving technological literacy (Morrison, 2006, [5]). Research has demonstrated that the integration of mathematics and science positively influences student attitudes and interest in school (Bragow, Gragow, & Smith, 1995, [6]), boosts their motivation to learn (Guthrie et al., 2000, [8]), and enhances academic achievement (Hurley, 2001, [9]). The national academy of engineering and the national research council (Katehi et al. 2009, [10]) outline five benefits of incorporating engineering into high school curricula: improved performance in mathematics and science, increased awareness of engineering, the ability to understand and engage in engineering design, and enhanced technological literacy. Given the numerous potential benefits of integrated SMASSE education, it is crucial to determine how teachers can effectively deliver this curriculum. Consideration of issues related to teacher support, instructional practices, teacher efficacy, and the materials required for implementing integrated SMASSE education is essential.

The research on teaching integrated mathematics and science provides a solid foundation for implementing integrated stem education. The successful integration of science and mathematics largely depends on teachers' understanding of the subject matter (Pang & Good, 2000, [11]). Many teachers have gaps in their subject content knowledge (Stinson et al., 2009), and asking math and science teachers to teach additional subjects may create new knowledge gaps and challenges (Stinson et al., 2009, [12]). Insights from research on effective practices in science and mathematics education can inform effective strategies for stem integration. (Zemelman et al. 2005, [13]) identify ten best practices for teaching math and science: using manipulates and hands-on learning, promoting cooperative learning, facilitating discussion and inquiry, encouraging questioning and conjectures, justifying thinking, writing for reflection and problem-solving, adopting a problem-solving approach, integrating technology, acting as a facilitator, and using assessment as an integral part of instruction.

II. RESEARCH METHOD AND DESIGN

A. Study Site

This study will be conducted in the secondary schools of selected districts in the Kellem Wollega Zone, specifically in Dale Wabara, Hawagelan, Sadi Chanka, and Dambi Dollo (formerly known as Sayo) Town. Dambi Dollo is located approximately 635 kilometers west of Addis Ababa, in the Kellem Wollega area of the Oromia Regional State. The town is situated at an altitude ranging from 1,701 to 1,827 meters sea level. According to the 2017 projection of report from the Statistical Agency Ethiopia, the population of Kellem Wollega is 1,040,585 1,040,585, comprising are and 518,103 123,077(11.82%) Of this population, 123,077 individuals (11.82%) reside urban area. Compared 2007 report by a statistical agency the urban population increased by about 2.3%.

B. Design of the Study

The researcher will use a descriptive survey design to conduct the research in terms of its appropriateness. This design is appropriate for getting detailed data from the respondents and appropriate to assess the status of the phenomenon. The researcher will use both qualitative and quantitative methods (mixed method). According to (Creswell, 2012, [7][14]), the core argument for a mixed methods design is that the combination of both forms of data provides a better understanding of a research problem than either quantitative or qualitative data by itself. In this process, (Creswell,2012, [14]) states that the researcher has to decide on the emphasis he will give to each form of data (priority), which data will be collected first (concurrent and sequential), how the researcher will "mix" the data (integrating and connecting), and how to use theory to guide the study(e.g., advocacy or social science theory). Accordingly, the researcher will use a mixed method since the method is appropriate to triangulate data obtained from questionnaires, interviews, and document analysis and the researcher used this method to integrate the study with scientific theory. Again this method is chosen by the researcher since the combinations of the two methods are convenient to get the detailed information available for the study.

C. Source of Data

Both primary and secondary data sources will be utilized in this study. Primary sources will be gathered from teachers, school principals, students, and classroom observations. Secondary data will be obtained from students' recorded documents and other results produced by students and teachers within the institution.

D. Population and Sampling Techniques

The research was conducted in a government secondary school in the Kellem Wollega zone of the Oromia regional state. This zone is located in the western region of Oromia. The researchers randomly selected six government secondary schools from the woredas (districts) within the zone. These woredas are Sayo, Dalle Wabera, Hawaglan, Sadi Chanka, and Dalle Sadi. Additionally, one school from the Dambi Dollo city administration will be included in the selection. Out of the 51 secondary schools in the Kellem Wollega zone, the following six schools will be selected: Ebisa Adugna, Chanka, Haro Sabbu, Kake, Burrayu, and Kellem secondary schools.

Using a 95% confidence level, a 5% margin of error, and an estimated population of 13,150 students from the six high schools, the calculated sample size was 388. The formula below (Cochran, 1977) was used to determine the sample size as

$n = \frac{N}{1+N(e^2)}$, N is the total population of students, n is the sample size and e is a marginal error. Using an enrollment of students 13,150 students, the sample size is proportionally allocated to each stratum (section and grade) students will finally selected using simple random sampling.

Retrieval Number: 100.1/ijmh.H1466048822
DOI: 10.35940/ijmh.H1466.11010924
Journal Website: www.ijmh.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

Also among 120 mathematics and science teachers, 80 teachers will be selected using the above sample formula. Thus, a total of 508 samples will be selected to collect relevant information. And students from each secondary school will be taken for the study by using random sampling. From the sample secondary schools, the researchers took some teachers including school principals of the selected schools, and obtained the relevant information available for study.

E. Research Instruments

The instruments used for data collection were determined by the needs of a given research and research questions. The research needs a wide quantitative description and there are things related to the implementation of SMASSE education which was described qualitatively. Therefore, through the use of multiple instruments; relevant data for the study will be collected.

i. Questionnaires

Many scholars emphasize the importance of questionnaires for collecting information from respondents. According to Key (1997), as cited in (Hailu Terefe,2012, [25]), a questionnaire is a tool for eliciting the feelings, beliefs, experiences, perceptions, or attitudes of a sample of individuals. The researcher will develop two types of questionnaires. One set will be administered to teachers to investigate the methods they use to enhance Mathematics and Science Education, their attitudes toward the Strengthening Mathematics and Science in Secondary Education (SMASSE) program, and the challenges they face in implementing MASSE. The items in this questionnaire will include a five-point scale for responses: strongly agree (5), agree (4), undecided (3), disagree (2), and strongly disagree (1), along with open-ended questions. The second set of questionnaires will be administered to students to assess their attitudes toward MASSE. This questionnaire will consist of 12 items, also utilizing a five-point scale for responses and open-ended questions, and will include items designed to explore the sectors in which students and their teachers are engaged. Reason: Improved clarity, vocabulary, and technical accuracy; corrected grammatical errors and punctuation.

ii. Interviews

Some interviews will be conducted with the directors of selected secondary schools and their students. Interviews are preferred over questionnaires due to their advantages, particularly in allowing researchers to probe specific responses and clarify or confirm information from respondents. The prepared open-ended interview questions include four questions for teachers, five questions for directors, and four questions for students. The interviews with students will be conducted in Afan Oromo. To facilitate the translation from English to Afan Oromo, the researcher will seek assistance from a lecturer specializing in Afan Oromo at Dambi Dollo University. The interviews with teachers and directors will be conducted in English, and all interviews will be recorded using a notebook. Finally, the responses from the interviews will be integrated with data from other instruments and analyzed.

iii. Observation

The observation checklist which includes five scale measurements i.e., very low, low=2, medium=3, high=4, and very high=5 will be developed by the researcher. The researcher will aim to obtain the following statement during observation: to assess the status of stem implementation level during teaching and learning inside the classroom, these include the assessment techniques that the teacher used, the involvement of students in teaching and learning, the involvement of the student in class and its implementation and to observe some of the factors that affect implementation inside the classroom that have close relation to the quality of education. Such factors include the availability of instructional materials, and facilities such as tables, chairs, and others.

F. Procedure of Data Collection

The data-gathering instruments were prepared in English language for teachers and school principals, but for students, it was prepared in Afan Oromo to overcome the problem of understanding and for free expression of ideas. The reason behind converting the questionnaire of students to Afan Oromo is to avoid bias among students who speak Afan Oromo or English because; in Kellem Wollega zone many students speak only Afan Oromo. The distribution, continuous follow-up, and the collection of questionnaires were made by the researcher himself. The researchers made, the objective of the study clear to all of the respondents to avoid confusion, get reliable information, and facilitate.

G. Data Analysis

In this section, all information was obtained from questionnaires administered to teachers and students, as well as interviews conducted with school directors, teachers, and students. An observation checklist will also be analyzed. Frequency counts and percentages will be employed as statistical methods to analyze and present the structured data collected from the questionnaires. Observations will be made quantitatively. To compare student satisfaction levels between schools, the researcher will use one-way ANOVA. For those comparisons that show statistically significant differences, Tukey's HSD will be applied to determine which groups differ significantly. Additionally, to compare satisfaction and quality between woredas and city administrations in the Kellem Wollega zone, the researcher will utilize the T-test to analyze the results. In this analysis, all p-values less than 0.05 will be considered statistically significant. To conduct these tests, the researcher will use SPSS version 15. Furthermore, to strengthen the information gathered through the questionnaires, qualitative data obtained from interviews and document analyses—including student and teacher documents and curriculum—will be analyzed and integrated with the quantitatively analyzed data.

Retrieval Number: 100.1/ijmh.H1466048822
DOI: 10.35940/ijmh.H1466.11010924
Journal Website: www.ijmh.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

III. RESULTS AND DISCUSSION

General Characteristics of Respondents

Table 1; General Characteristics of Respondents

	Item	Number of Teachers	Numbers of Students
Sex	Male	84	
	Female	30	
Age	15-18		
	19-22		
	23-27	20	
	28-30	48	
	Above 31	46	
Education level	9^{th}		77
	10^{th}		98
	11^{th}		117
	12^{th}		100
	Diploma	4	
	Degree	85	
	Masters	25	
Year of work experience	Less than two years	13	
	2-5 years	40	
	More than five years	61	

A. Questionnaire on How Teachers are Integrating

The primary objective of the study was to identify the methods teachers use to integrate science and mathematics into the curriculum. Some of the methods employed to achieve this integration include assigning homework, assigning project work, utilizing the PDSI and ASEI approaches in student-centered teaching and learning, providing worksheets, and implementing other SMASSE strategies.

Table 2: Rate of Giving Assignments to Improve SMASSE

How often do you give assignments?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	12	3.1	10.5	10.5
	Sometimes	63	16.1	55.3	65.8
	Rarely	34	8.7	29.8	95.6
	Never	5	1.3	4.4	100.0
	Total	114	29.1	100.0	

Most teachers are assigning tasks to strengthen students' skills in mathematics and science. According to Table 2, approximately 63 percent of teachers assign work to integrate these two subjects. Educators are attempting to combine the disciplines by providing more assignments that enhance students' performance in mathematics. However, around 40 percent of teachers assign work less frequently. This inconsistency impacts the implementation of the integration of science and mathematics from the perspective of the SMASSE approach.

Table 3: Rate of Project Works That Are Given to Students

How often do you give project work?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	4	1.0	3.5	3.5
	some times	38	9.7	33.3	36.8
	Rarely	62	15.8	54.4	91.2
	Never	10	2.6	8.8	100.0
	Total	114	29.1	100.0	

Around 42 percent of teachers were giving projects to students to improve their students' academic performance whereas more than 70 percent were giving rarely to their students. The schools should work on these gaps to improve the implementation of SMASSE.

Table 4: Rate of Giving Practical Work to Implement SMASSE

How often do you work practical work with your students?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	9	2.3	7.9	7.9
	some times	51	13.0	44.7	52.6
	Rarely	45	11.5	39.5	92.1
	Never	9	2.3	7.9	100.0
	Total	114	29.1	100.0	

Providing practical assignments to students in their study areas is essential for enhancing the implementation of the Strengthening Mathematics and Science Education (SMASSE) initiative.

Most teachers practice assigning practical work to strengthen students' understanding of science and mathematics. Approximately 60 percent of teachers provide practical assignments that promote the integration of science and mathematics. However, around 50 percent do not frequently assign practical work. This lack of engagement hinders student achievement in both subjects and negatively impacts the implementation of SMASSE.

Table 5: Student-Centered Approach

How Often do you use Student-Centered Approach?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	always	44	11.2	38.6	38.6
	some times	49	12.5	43.0	81.6
	Rarely	21	5.4	18.4	100.0
	Total	114	29.1	100.0	

Student student-centered approach is one of the pillars of implementing SMASSE. More than 80 percent were practicing a fully student-centered approach to strengthen mathematics in the study area.

Table 6: Teachers Applying SMASSE Approach

Do you use SMASSE Approach?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	33	8.4	28.9	28.9
	some times	54	13.8	47.4	76.3
	Rarely	19	4.8	16.7	93.0
	Never	8	2.0	7.0	100.0
	Total	114	29.1	100.0	

According to Table 6, approximately 76.3 percent of teachers in the study area are implementing the SMASSE program to enhance students' performance in mathematics. However, many students in this area perceive mathematics as a difficult subject, which presents a significant challenge to the application of SMASSE in-service training practices. Additionally, some teachers do not practice the SMASSE approach at all, while others rarely attempt to incorporate its strategies.

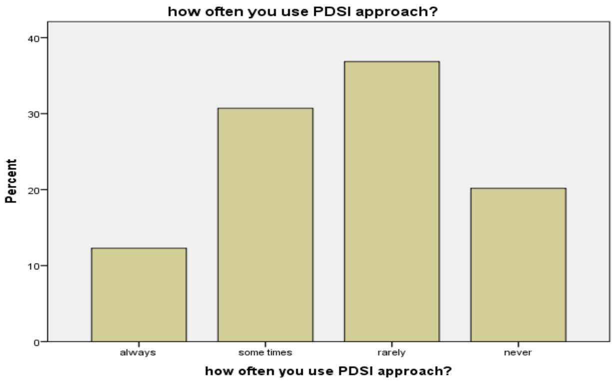

Figure 1: Frequency of Using PDSI Approach

PDSI approach is common in pedagogy in order to improve the students' performance in their academic achievement.

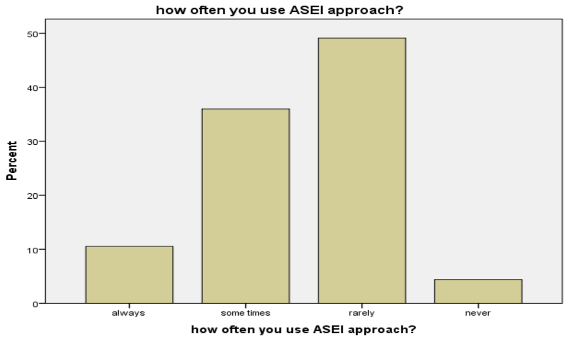

Figure 2: Frequency of Using ASEI Approach

The implementation of the ASEI approach to strengthen mathematics and science education is approximately 50 percent. This indicates that half of the teachers are not utilizing the approach to enhance the integration of science and mathematics education in the study area. Therefore, there is a significant need for increased awareness to boost the percentage of teachers who implement the ASEI method in this region.

B. Questionnaire on Factors Affecting Implementation of SMASSE

Table 7: Teacher-Student Ratio Implementation

Do you agree that Teacher Student Ratio affect Implementation of SMASSE?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	40	35.1	35.1	35.1
	Agree	52	45.6	45.6	80.7
	Disagree	18	15.8	15.8	96.5
	strongly disagree	4	3.5	3.5	100.0
	Total	114	100.0	100.0	

According to Table 7, more than 80 percent of responses indicate that the teacher-student ratio affects the implementation of the Strengthening Mathematics and Science in Secondary Education (SMASSE) program. Having a large number of students in a single class makes it very challenging to address the needs of each student. According to the Ministry of Education (MOE) report from 2011, the national average teacher-student ratio was 57, with the highest ratio recorded in the Somali region at 81 (both figures from the 2010/11 academic year,[21,22, and 23]).

Retrieval Number: 100.1/ijmh.H1466048822
DOI: 10.35940/ijmh.H1466.11010924
Journal Website: www.ijmh.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

This trend complicates teachers' efforts to enhance the teaching of science and mathematics in the classroom. It was noted that the allocated schedule was insufficient to effectively deliver the required courses within the designated hours. The number of teachers increased by 2.5 times in primary education and 3.8 times in secondary education from 2000/01 to 2010/11. In the 2010/11 academic year, there were 310,000 teachers in primary schools and 530,000 teachers in secondary schools. The share of female teachers was from 30 to 37% in primary schools and 7 to 18% in secondary schools, indicating that female teachers are less especially at the secondary level (MOE, 2005, 2006, 2011) [20].

Table 8: Text Book Student Ratio as Factor

Do you agree that Student-Text book Ratio Affect Implementation of SMASSE?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	51	44.7	44.7	44.7
	Agree	42	36.8	36.8	81.6
	Disagree	17	14.9	14.9	96.5
	strongly disagree	4	3.5	3.5	100.0
	Total	114	100.0	100.0	

About 91 percent of teachers indicated that the imbalance between the number of books and the number of students in schools is a significant factor that must be addressed to strengthen science and mathematics education. The shortage of textbooks and the large class sizes are primary obstacles to implementing student-centered education.

Table 9: Lack of Laboratory Class

Do you agree that Lack of Laboratory Class affect Implementation of SMASSE?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	48	42.1	42.1	42.1
	Agree	56	49.1	49.1	91.2
	Disagree	6	5.3	5.3	96.5
	strongly disagree	4	3.5	3.5	100.0
	Total	114	100.0	100.0	

According to Table 9, more than 90 percent of responses indicate that the lack of laboratory facilities is a critical problem in integrating these two core courses in education. Since the integration relies on laboratory work, project-based activities, and other innovative methods, the absence of a laboratory means that students cannot engage in experimental activities.

Table 10: lack of Computers as Factor

Do you agree that Lack Computers affect Implementation of SMASSE?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	38	33.3	33.3	33.3
	Agree	60	52.6	52.6	86.0
	Disagree	13	11.4	11.4	97.4
	strongly disagree	3	2.6	2.6	100.0
	Total	114	100.0	100.0	

Approximately 80 percent of studies indicate that schools have a limited number of computers. In today's technological world, computers play a vital role in integrating science and mathematics. Furthermore, the lack of computers is a significant barrier to the successful implementation of the Strengthening Mathematics and Science Education (SMASSE) initiative.

Table 11: Lack of Planned Schedule

Do you agree that Lack of Properly Planned Schedule (Time Table) affect Implementation of SMASSE?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	40	35.1	35.1	35.1
	Agree	59	51.8	51.8	86.8
	Disagree	11	9.6	9.6	96.5
	strongly disagree	4	3.5	3.5	100.0
	Total	114	100.0	100.0	

According to Table 11, approximately 80 percent of respondents indicate that the time allocated to complete courses is insufficient. A study shows that most high school courses are not completed due to a lack of adequate time. This time shortage results from both internal and external factors. Internal factors include the absence of a well-structured lesson plan and insufficient time for course completion, while external factors, also known as environmental factors, encompass issues such as inadequate security around schools and family background, including economic status.

Retrieval Number: 100.1/ijmh.H1466048822
DOI: 10.35940/ijmh.H1466.11010924
Journal Website: www.ijmh.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

Table 12: Teachers Opinion on Implementation of SMASSE

Do you Think Implementation of SMASSE Difficult?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	41	36.0	36.0	36.0
	Agree	50	43.9	43.9	79.8
	Disagree	20	17.5	17.5	97.4
	strongly disagree	3	2.6	2.6	100.0
	Total	114	100.0	100.0	

The study shows that the implementation of SMASSE in the study area is somewhat challenging. More than 75 percent of the study participants indicate that the integration of science and mathematics is difficult to implement in this region. This difficulty arises primarily because most schools are located in rural areas, where both students and teachers have limited access to the Internet and other technological resources. Additionally, it was found that there is a lack of capacity-building training in the schools, and many teachers lack experience in teaching. Even though teachers receive training on the SMASSE initiative, they often find other opportunities and leave their positions without providing sufficient service to the school.

C. Questionnaire on Attitude of Students Toward SMASSE

Table 13: Teachers are Confident While Teaching

Teachers are Confident While Teaching					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	52	13.3	13.3	13.3
	Agree	119	30.4	30.4	43.6
	Undecided	78	19.9	19.9	63.5
	Disagree	130	33.2	33.2	96.7
	strongly disagree	13	3.3	3.3	100.0
	Total	392	100.0	100.0	

Approximately 40 percent of the study indicates that teachers feel confident while teaching, while less than 36 percent express disagreement on this issue. Additionally, about 20 percent of the study participants are undecided regarding their confidence levels. It has been observed that more experienced teachers are leaving their positions for better job opportunities. As a result, most teachers do not remain in their roles for more than three to five years. Consequently, the confidence of teachers in the classroom within the study area is somewhat undermined due to a shortage of experienced educators and a lack of capacity-building training in the schools.

Table 14: Mathematics Lessons are Student Centeredness

Mathematics Lessons are More Student-Centered					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	44	11.2	11.2	11.2
	Agree	114	29.1	29.1	40.3
	Undecided	79	20.2	20.2	60.5
	Disagree	140	35.7	35.7	96.2
	strongly disagree	15	3.8	3.8	100.0
	Total	392	100.0	100.0	

Approximately 40 percent of studies indicate that mathematics instruction is more student-centered, while over 35 percent suggest that lessons are not particularly student-centered. It has been identified that there are few project-based lessons available. Consequently, the lack of such designations in mathematics lessons significantly impacts the integration of mathematics and science.

Table 15: Science Lessons are Student Centered

Science Lessons Student-Centered					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	strongly agree	42	10.7	10.7	10.7
	Agree	114	29.1	29.1	39.8
	Undecided	88	22.4	22.4	62.2
	Disagree	134	34.2	34.2	96.4
	strongly disagree	14	3.6	3.6	100.0
	Total	392	100.0	100.0	

Similarly to Table 14, science course lessons are more focused on theoretical rather than practical. Such designation also affects the implementation of the integration of science and mathematics. In the study area, most teachers have no lesson plan in such a way as to implement this education.

Retrieval Number: 100.1/ijmh.H1466048822
DOI: 10.35940/ijmh.H1466.11010924
Journal Website: www.ijmh.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

Table 16: Integration of Science with Mathematics

Do Teachers Integrate Science with Mathematics Depending on Course Nature?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	72	18.4	18.4	18.4
	Undecided	116	29.6	29.6	48.0
	Disagree	116	29.6	29.6	77.6
	strongly disagree	88	22.4	22.4	100.0
	Total	392	100.0	100.0	

More than 18 percent of the responses indicate that teachers attempt to integrate science with mathematics. Conversely, over 51 percent of respondents indicate that teachers are not making an effort to integrate these subjects, depending on the nature of the courses. In the study area, there has not been a significant plan implemented to enhance the integration of the SMASSE program.

Table 17: ASEI and PDSI Approach

Do Teachers use ASEI and PDSI Approach During Lesson?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	66	16.8	16.8	16.8
	Undecided	122	31.1	31.1	48.0
	Disagree	116	29.6	29.6	77.6
	strongly disagree	88	22.4	22.4	100.0
	Total	392	100.0	100.0	

Around 51 percent of students disagree with the issue, and more than 31 percent are unaware of what ASEI and PDSI are. This indicates that the strengthening of science and mathematics education in schools is significantly less than intended. Most schools in the study area are not employing these methods in any of their lessons. This creates a substantial gap between teachers and students regarding the integration of science and mathematics education in the study area.

Table 18: Enough Text Books of Science and Mathematics

Does your School have Enough Textbooks for Science and Mathematics?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	72	18.4	18.4	18.4
	Undecided	116	29.6	29.6	48.0
	Disagree	116	29.6	29.6	77.6
	strongly disagree	88	22.4	22.4	100.0
	Total	392	100.0	100.0	

From the table above, approximately 50 percent of the respondents disagreed with the question. This suggests that there are a limited number of books compared to the number of students in the study area. Consequently, this shortage of textbooks is one of the factors that hinder the implementation of SMASSE. Therefore, addressing this issue should be a primary focus for relevant organizations to enhance the availability of books and improve the implementation of SMASSE in the area.

Table 19: Student Participation During Class Room

Do you Actively Participate During Practical Class					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	188	48.0	48.0	48.0
	No	111	28.3	28.3	76.3
	Undecided	93	23.7	23.7	100.0
	Total	392	100.0	100.0	

A study shows that more than 28 percent of students were not actively participating in the classroom, and around 24 percent were uncertain about their participation. This indicates that more than half of the students in the study area are not engaged in their classes. To enhance science and mathematics education, student participation in the classroom is essential. Without active participation from students, the objectives of the Strengthening Mathematics and Science Education (SMASSE) program cannot be achieved.

IV. DISCUSSION

This study was conducted in the Kellem Wollega Zone across five selected schools. The target population was drawn from five different locations within the zone, comprising a total of 506 samples, of which 392 are students and 114 are teachers and school principals. Fortunately, the researchers were able to obtain the entire sample population as outlined in the methodology. Therefore, the researchers believe they have gathered sufficient data from the site. This study aimed to identify the methods teachers use to integrate science and mathematics, as well as the factors that affect the implementation of integrated science and mathematics education. Additionally, it examines students' attitudes toward the integration of these subjects in secondary schools within the Kellem Wollega Zone of Ethiopia. The primary objective of this study is to identify methods that enhance science and mathematics education. The methods examined include the PDSI method, ASEI method, student-centered approach, and open-ended approach. Most schools implement these strategies to improve mathematics and science education.

These findings are consistent with the research conducted by CEMASTEA (2005,[15]) and Hobart and L. Hannon (2003, [17][24][26][27][28][29][30]. However, the availability of adequate resources remains a challenge across all schools, with rural schools facing particularly significant difficulties in providing quality mathematics and science instruction. The introduction of computers and associated information technologies has exacerbated the resource issue in many rural areas.

The second objective of the study was to assess students' attitudes toward the Strengthening Mathematics and Science Education (SMASSE) program. The factors examined included students' attitudes toward science and mathematics, negative interactions between students and teachers, feedback from teachers, teaching methodologies, teachers' competencies, and school management. These findings align with those of (Njuguna B.M. 1999, [16,18] and (Noboru Saito,1998, [19]), which indicated a negative student attitude toward science and mathematics, as well as negative attitudes from teachers and parents regarding their children's performance. Finally, the study evaluated the factors that impede the implementation of the Strengthening Mathematics and Science Education (SMASSE) program. These factors included the student-teacher ratio, student-text ratio, disproportionate numbers of students to class size, lack of facilities, and an inadequate quality assurance system. This finding aligns with the Ministry of Education (MOE) report from 2011.

V. CONCLUSION

Teachers integrate science and mathematics using the PDSI and ASEI approaches, along with a student-centered methodology, primarily through the SMASSE framework. They engage students by assigning projects, conducting practical work, providing assignments and worksheets, and fostering team spirit among students. However, several factors hinder the implementation of the SMASSE approach in the study area, including an unfavorable teacher-student ratio, disproportionate class sizes, student attitudes toward science and mathematics, a lack of laboratory facilities and equipment, an absence of a planned schedule, insufficient access to computers, inadequate assessment practices, limited time to complete the curriculum, and a lack of a robust quality assurance system. On the other hand, students exhibit a negative attitude toward SMASSE, which is reflected in their perceptions of mathematics, student-teacher interactions, and feedback from teachers, teaching methods, course content, teacher competency, school management, and limited participation in the classroom. The findings indicate that the effective adoption and implementation of the ASEI-PDSI approach to teaching mathematics and science can lead to improved learning outcomes in secondary mathematics. The SMASSE approach, in particular, has been shown to enhance learning outcomes in secondary school mathematics in the Kelem Wollega zone and throughout Ethiopia. Therefore, teachers should embrace the principles of SMASSE and incorporate them into their classrooms to achieve better learning outcomes.

DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been sponsored or funded by any organization or agency. The independence of this research is a crucial factor in affirming its impartiality, as it has been conducted without any external sway.
- **Ethical Approval and Consent to Participate:** The data provided in this article is exempt from the requirement for ethical approval or participant consent.
- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Authors Contributions:** The authorship of this article is contributed equally to all participating individuals.

REFERENCES

1. Furner, J. M., & Kumar, D. D. (2007). The mathematics and science integration argument: A stand for teacher education. Eurasia Journal of Mathematics, Science and Technology Education, 3(3), 185-189. https://doi.org/10.12973/ejmste/75397
2. Fllis, A. K., & Fouts, J. T. (2001). Interdisciplinary curriculum: The research base: The decision to approach music curriculum from an interdisciplinary perspective should include a consideration of all the possible benefits and drawbacks. Music Educators Journal, 87(5), 22-68. https://doi.org/10.2307/3399704
3. Baluch, M. U. H., & Shahid, S. (2008). Determinants of enrollment in primary education: a case study of district Lahore. *Pakistan Economic and Social Review*, 161-200.
4. Frykholm, J., & Glasson, G. (2005). Connecting science and mathematics instruction: Pedagogical context knowledge for teachers. School Science and Mathematics, 105(3), 127. https://doi.org/10.1111/j.1949-8594.2005.tb18047.x
5. Morrison, B. (2006). School bullying and restorative justice: Toward a theoretical understanding of the role of respect, pride, and shame. Journal of Social Issues, 62(2), 371-392. https://doi.org/10.1111/j.1540-4560.2006.00455.x
6. Bragow, D., Gragow, K.A., & Smith, E. (1995). Back to the future: Toward curriculum integration. Middle School Journal, 27, 39–46. https://doi.org/10.1080/00940771.1995.11496152
7. Stohlmann, M., Moore, T. J., & Roehrig, G. H. (2012). Considerations for teaching integrated STEM education. Journal of Pre-College Engineering Education Research (J-PEER), 2(1), 4. https://doi.org/10.5703/1288284314653
8. Guthrie, J. T., Wigfield, A., & VonSecker, C. (2000). Effects of integrated instruction on motivation and strategy use in reading. Journal of Educational Psychology, 92(2), 331. https://doi.org/10.1037/0022-0663.92.2.331
9. Hurley, S. (2001). Perception and action: Alternative views. Synthese, 129, 3-40. https://doi.org/10.1023/A:1012643006930
10. Feder, M., Pearson, G., & Katehi, L. (Eds.). (2009). Engineering in K-12 education: Understanding the status and improving the prospects. National Academies Press.
11. Pang, J., & Good, R. (2000). A review of the integration of science and mathematics: Implications for further research. School science and mathematics, 100(2), 73-82. https://doi.org/10.1111/j.1949-8594.2000.tb17239.x
12. Stinson, K., Harkness, S. S., Meyer, H., & Stallworth, J. (2009). Mathematics and science integration: Models and characterizations. School Science and Mathematics, 109(3), 153-161. https://doi.org/10.1111/j.1949-8594.2009.tb17951.x
13. Zemelman, S. (2005). Best practice, today's standards for teaching and learning in America's schools.
14. Klassen, A. C., Creswell, J., Plano Clark, V. L., Smith, K. C., & Meissner, H. I. (2012). Best practices in mixed methods for quality of life research. Quality of Life Research, 21, 377-380. https://doi.org/10.1007/s11136-012-0122-x

15. Kotrlik, J. W. K. J. W., & Higgins, C. C. C. C. C. (2001). Organizational research: Determining the appropriate sample size in survey research appropriate sample size in survey research. Information technology, learning, and performance journal, 19(1), 43.
16. Ndirangu, C. W., Nyagah, G. M., & Kimani, G. N. (2017). The level of implementation of ASEI/PDSI classroom practices in science subjects: A case of SMASSE project, Kenya. International Journal of Learning, Teaching and Educational Research, 16(5), 118-140.
17. Harmon, H. L., Henderson, S. A., & Royster, W. C. (2003). A Research Agenda for Improving Science and Mathematics Education in Rural Schools. Journal of Research in Rural Education, 18(1), 52-58.
18. Njuguna, B. M. (1999). The findings from baseline studies by SMASSE Project SMASSE Project Bulletin. Unpublished.
19. Saito, N., & Kim, B. Y. (1998). Comparison of Japan-Korean Mathematical Achievement Using the Climbing-Learning Method. Proceedings of ICMI-EARCOME 1 Vol, 3.
20. Berlin, D. F., & Lee, H. (2005). Integrating science and mathematics education: Historical analysis. School Science and Mathematics, 105(1), 15-24. https://doi.org/10.1111/j.1949-8594.2005.tb18032.x
21. Asfaw, E., Otore, D., Ayele, T., & Gebremariam, Z. (2009, January). Science and mathematics secondary education in Ethiopia. In An Option paper presented at the Technical Workshop on Science and Mathematics Secondary Education in Africa (SEIA) Follow-up Program.
22. Ababa, A. (2014). EARLY GRADE MATHEMATICS ASSESSMENT (EGMA) IN ETHIOPIA: BASELINE STUDY REPORT.
23. Walelign, T. (2014). Assessment of students' mathematical competency, a case study in Dire-Dawa University. Ethiopian Journal of Education and Sciences, 9(2), 1-15.
24. Hannon, J., Hirst, D., & Riddle, M. (2011). Implementing e-learning: A migration story. *Changing demands, changing directions. Proceedings ascilite Hobart*, 557-561.
25. Terefe, E. (2018). Practices and challenges of postgraduate diploma in teaching in Ethiopian PGDT trainer universities. *IAHRW International Journal of Social Sciences Review*, *6*(7), 1240-1247.
26. Kapur, Dr. R. (2024). Understanding Education System in Rural Communities. In Indian Journal of Management and Language (Vol. 2, Issue 2, pp. 33–39). https://doi.org/10.54105/ijml.a2069.02021022
27. Kapur, Dr. R. (2024). Understanding the Developments in System of Education within Rural Communities. In International Journal of Management and Humanities (Vol. 10, Issue 9, pp. 18–23). https://doi.org/10.35940/ijmh.j1714.10090524
28. Gnanamkonda, V., Koundinya, C., & Krishna, C. G. (2019). ICT in Rural School Education: Impacting on Children Cognition. In International Journal of Innovative Technology and Exploring Engineering (Vol. 8, Issue 12, pp. 1697–1703). https://doi.org/10.35940/ijitee.l3176.1081219
29. A. G. Vadivelan, P. Pandia Rajammal, The Major Issues of English Language Teaching in Rural Areas in India. (2020). In International Journal of Recent Technology and Engineering (Vol. 8, Issue 4S4, pp. 18–20). https://doi.org/10.35940/ijrte.d1007.1284s419
30. Galadima, U., Ismail, Z., & Ismail, N. (2019). A New Pedagogy for Training the Pre-service Mathematics Teachers Readiness in Teaching Integrated STEM Education. In International Journal of Engineering and Advanced Technology (Vol. 8, Issue 5c, pp. 1272–1280). https://doi.org/10.35940/ijeat.e1181.0585c19

AUTHORS PROFILE

Tarekegn D. Gelu is an accomplished mathematician and educator with over five years of teaching experience at the university level. Currently serving as an Assistant Professor at Dambi Dollo University, he is dedicated to fostering a deep understanding of mathematical concepts among his students. He is also a PhD scholar at IIT Hyderabad, where he is engaged in advanced research in mathematics. His academic journey is marked by a commitment to excellence and a passion for teaching. In addition to his academic pursuits, He possesses strong software, social, and problem-solving skills, enabling him to effectively engage with students and colleagues alike. He has actively participated in public and government issues, demonstrating his commitment to community engagement and the application of mathematical principles to real-world challenges.

Yohannis A. Wakjira is an assistant professor at Dambi Dollo University, where he has been actively involved in teaching mathematics for more than seven years. His academic journey reflects a strong dedication to enhancing student learning and fostering a collaborative academic environment. Yohannis has engaged in significant research endeavors that contribute to the field of mathematics, aiming to bridge theoretical knowledge with practical applications.