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School Teachers' Perspectives on the Use of Algebra Tiles to Operations on Integers

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Abstract

This paper is based on the first author's (researcher) experience as a mathematics teacher trainer based on his M.Ed. 'Internship course.' The second author being the course facilitator has played a facilitative role in the development of the training module and the successful conduction of Teacher Professional Development (TPD) sessions. This study aimed to explore perspectives on the use of algebra tiles (as physical manipulatives) to basic arithmetic operations on integers - addition (+), subtraction (−), multiplication (×), and division (÷), based on the experiences of 22 school mathematics teachers of Kathmandu, Nepal (who participated in TPD). This study utilized a qualitative research technique, Concrete-Representational-Abstract (C-R-A) instructional sequence, and triangulation. The data generation tools were participant observations, researcher-participant interaction, participant worksheets, reflection forms, end-reflection videos, and photos. The data analysis unveiled that the participants had a positive outlook towards the use of algebra tiles (as physical manipulatives), and they viewed it as effective concerning operations on integers. As a result, the participants were motivated enough and were determined to apply it in their mathematics classroom teaching, even though it would be difficult to implement it properly due to time constraints – cost, availability, time, and management. However, the participants suggested Book Free Day - an initiative introduced (2023, April 27) by Kathmandu Metropolitan City, where students go to school without books and bags every Friday, and remedial teaching as the most appropriate occasions to implement algebra tiles properly.

Keywords: Algebra tiles, physical manipulatives, arithmetic operations, integers, Book Free Day

Introduction

In our (human being) day-to-day life, we perform various kinds of activities. For instance; in the life of a grocery shopkeeper – he/she buys the grocery items (from the

retailer) and sells them to the customer. Besides, the shopkeeper keeps a record of the items (sale and purchase), pays electricity bills, pays rent to the landlord (for using another's space to run the shop), and also deposits money (earnings) in the bank. All these activities, primarily involve the application of four basic arithmetic operations (BAO), namely: addition (+), subtraction (−), multiplication (×), and division (÷). Concerning it, Raza (2022) in his study stated that these four BAOs are immensely associated with the daily life activities (e.g., purchasing goods and paying bills) of a human being.

Furthermore, in Nepal's Basic Education Curriculum (grades 6-8) regarding mathematics, the ability of grade 7 students to perform 'simplification of integers' through the application of four BAO is assigned as a learning outcome for the unit – Integers (Curriculum Development Centre [CDC], 2020). Moreover, the BAO on integers is considered one of the fundamental concepts in secondary-level mathematics education (Raza, 2022). This signifies the importance of having the ability (by the students) - to perform simplification of integers (as a pre-requisite), concerning solving problems related to topics of secondary level mathematical units assigned in Nepal's Secondary Level Education Curriculum (grade 9-10) – sets, algebra, arithmetic, geometry, mensuration, trigonometry, statistics and probability (CDC, 2021). The lack of that ability may lead students to such a scenario where they can experience struggle in the teaching-learning process of those secondary-level mathematical units. In that regard, Fuadiah et al. (2017) asserted that students who experience difficulty in learning concepts that are fundamental to the development of other concepts will also experience struggle in the process of learning those subsequent (other) concepts. Hence, this suggests the necessity for students to accomplish the ability – to perform simplification on integers correctly (in grade 7 itself), to enhance their prospect of performing well in higher-grade mathematics, or to enhance mathematics competence in general (Torbeyns et al., 2015).

Regarding grades 8 and 10, the report from the National Assessment of Student Achievement (NASA) 2019 (for grade 10) and NASA 2020 (for grade 8), issued by the Education Review Office (ERO), Nepal suggested that the performance of students (from these grades) in mathematics is not encouraging. It has been reported that in mathematics majority of students had achieved less than 50% of learning outcomes (as mentioned in curriculum) - highlighting 59% and 67.9% of students achieving below the basic proficiency level, in grade 10 and grade 8 respectively (ERO, 2020, 2022).

Past studies such as Makonye and Fakude (2016), Toh et al. (2017), and Widjaja et al. (2011) have illustrated that students struggle in solving basic mathematical problems that comprise BAO on integers, notably addition and subtraction. Furthermore, students face more difficulty when two numbers possess a negative $(-)$ sign, regardless of arithmetic operations, as students were taught in such a way that adding two negative numbers will produce a negative number, whereas multiplying two negative numbers will produce a positive number (Fuadiah et al., 2017). This creates confusion among students – they not being able to clearly (and easily) understand - why the numbers operate in that manner (Khalid & Embong, 2020). Consequently, it makes it difficult for students to make sense of arithmetic operations on integers; for example, why addition of negative integer 2 and negative integer 1 equal to negative integer 3, i.e., $(-2) + (-1) = -3$? Or why multiplication of negative integer 2 and negative integer 1 equal to positive integer 2, i.e., $(-2) \times (-1) = +2$?

In that regard, Khalid and Embong (2020) stated that students are encouraged to follow rules and procedures very abstractly instead of approaching them through models for better conceptual understanding (which is key to learning mathematics), as one of the likely reasons. That scenario is somehow similar to the context of mathematics education in Nepal, where in regards to teaching mathematics units that are abstract, the teachers focused more on the development of Procedural Knowledge (PK) of students as compared to Conceptual Knowledge (CK) – predominant employment of conventional method (lecture: teacher-centric) being one of the likely reasons, as the teachers view the implementation of model (e.g., manipulatives) in mathematics classroom teaching difficult because of need to construct enormous amount of concrete materials (Manandhar et al., 2022).

Therefore, in general, Drushlyak et al. (2021) called for updated methodological tools that will make students inclined toward mathematics and enhance their learning outcomes. Accordingly, Khalid and Embong (2020) suggested the use of algebra tiles (as manipulatives), because they found it more effective as compared to other models (of abstract representation of abstract mathematical concepts) like number line - which is (from their perspective) particularly less effective in regards to arithmetic operations on integers – multiplication $(\times)$ and division $(\div)$.

Globally, a couple of studies were found to be done, particularly in regards to the use of algebra tiles (as manipulatives) in mathematics teaching of - algebra (Abdul-Karim et al., 2023), arithmetic operations on integers (Khalid & Embong, 2020),

operations on fraction (Klu et al., 2023), and linear equation in one variable (Rini, 2022). Besides, locally (in the context of Nepal), a couple of studies such as Jaisi (2020), Pande (2019), and Shahi (2015) were found to be done, particularly regarding the use of algebra tiles in teaching algebra. There seems to be an absence of study regarding BAO on integers.

Furthermore, all those studies (both globally and locally) were conducted through quantitative, quasi-experimental, action research design using achievement test scores: pre-test and post-test. Moreover, Pande (2019) suggested conducting further studies about knowing the perspectives of teachers towards the use of manipulatives such as algebra tiles. As far as the researcher knows, in the context of Nepal, such a study is uncommon. However, globally (in Indonesia), Tjandra (2023) conducted a similar study through survey and interview research design using a Likert scale to explore the effectiveness of using manipulatives in mathematics teaching in inclusive education programs in elementary school.

Besides, the researcher came across the significance of 'algebra tiles' (in the first semester) while pursuing a Master in Mathematics Education (M.Ed.) in 2021 from one of the universities of Nepal. The researcher learned that algebra tiles can be utilized as physical manipulatives to make students better understand the concepts of BAO on integers by providing hands-on learning activities (Sullah et al., 2017). So, later, in the fourth semester, when the researcher got an opportunity to conduct Teacher Professional Development (TPD), as a part of the 'Internship course,' he decided to conduct his TPD based on algebra tiles. TPD aims to make teachers competent in their profession by enhancing their abilities, understanding, and effectiveness in the classroom (Panthee, 2023). Through practicing his learning, primarily the researcher wanted to inquire about the perspectives of school mathematics teachers regarding the use of algebra tiles (as physical manipulatives) to operations on integers, in their mathematics classroom teaching. Thus, the guiding research question is: How do school mathematics teachers view the use of algebra tiles (as physical manipulatives) to operations on integers? This paper is based on TPD sessions that were carried out face-to-face (and free of cost).

Literature Review

Operations on Integers

Integers ($\mathbb{Z}$) refer to the union of a set of positive ($+$) natural numbers: $\mathbb{Z}^+ = \{1, 2, 3, \ldots\}$; zero (0); and a set of negative ($-$) natural numbers: $\mathbb{Z}^- = \{-1, -2, -3, \ldots\}$

i.e., $\mathbb{Z} = \mathbb{Z}^+ \cup \{0\} \cup \mathbb{Z}^-$. Therefore, in this study, operations on integers refer to problems comprising integers that are put up with basic arithmetic operations of addition ($+$), subtraction ($-$), multiplication ($\times$), and division ($\div$); and to assist participants in making sense of problems related to it, algebra tiles were utilized (Khalid & Embong, 2020).

Manipulatives

In the context of mathematics education, manipulatives are a kind of concrete materials that can be touched, moved, and employed in the teaching-learning process; and that assist in the illustration of abstract mathematical concepts (Heddens, 1997; Rini, 2022). Thus, providing hands-on learning experiences to the learners (Sullah et al., 2017) and a way to develop CK (Manandhar et al., 2022). In addition, manipulatives also come in virtual forms such as interactive software (Tjandra, 2023). Various kinds of manipulatives can be used in mathematics education such as counters, pattern blocks, base ten blocks, calculators, and students' fingers (Mink, 2009); additionally, algebra tiles, geoboard, and tangram (Pande 2019). This study is limited to the use of 'algebra tiles' as physical manipulatives.

Manipulatives are widely used in mathematics classroom teaching to assist students' conceptual understanding of the mathematical contents (Ikawati & Kowiyah, 2021) and it has proven effective in doing so (Tjandra, 2023). For instance; the use of manipulatives enhances conceptual understanding of mathematical contents such as solid geometry (Hidayah et al., 2018), operations on integers (Khalid & Embong, 2020), operations on fractions (Klu et al., 2023), and algebra (Larbi & Okyere, 2014). Manipulatives provide a real visual representation of abstract mathematical concepts to the learners, which in turn can enhance their understanding and grasping of those abstract mathematical concepts (Lafay et al., 2019; Tjandra, 2023). That is why, worldwide there has been an ongoing encouragement to integrate manipulatives in mathematics teaching (Watt-Douglas & George, 2021).

In the teaching-learning process of mathematics, the use of manipulatives promotes engagement, makes sure that students participate actively in an activity, and improves students learning (Larbi & Okyere, 2014). Additionally, Tjandra (2023) stated that the use of manipulatives strengthens the learners' problem-solving skills as well as supports learners with different learning styles (e.g., kinesthetic, visual). Furthermore, studies like Rini (2022), and Watt-Douglas and George (2021) talked about the

significance of manipulatives in closing the gap between male and female students, regarding performance in mathematics. Fascinatingly, Bouck and Park (2018) in their study stated that in regards to mathematics teaching, numerous research studies have validated the use of manipulatives as an effective method.

Algebra Tiles

Algebra tiles are kind of tiles that come in square and rectangular shapes, representing variables and numbers (Rini, 2022).

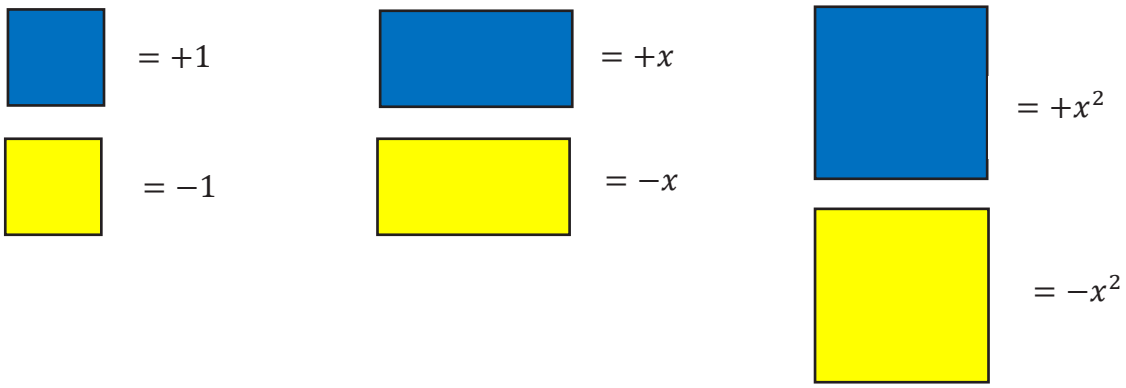

Figure 1 illustrates that there are three different algebra tiles – two square-shaped (± 1: unit and $\pm x^2$) and one rectangular-shaped ($\pm x$, in the middle). Each tile possesses two different colors – blue and yellow representing positive $(+)$ and negative $(-)$ values respectively. One color is on one side of the tile (say, blue), while the other color is on the flip side of the tile (then, yellow). Additionally, it illustrates that (± 1) and $(\pm x^2)$ are the smallest and the largest tiles respectively.

Zero-Sum Pair Concept

The two smallest blue and yellow tiles representing $+1$ and -1 respectively are additive inverses of each other and such a pair of tiles represents a zero-sum pair (Khalid & Embong, 2020). Figure 2 illustrates algebra tiles (unit) representing a zero-sum pair: $(+1) + (-1) = 0$.

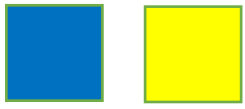

Fig. 2. Zero-sum pair $(+1) + (-1) = 0$

Similarly, the same can be said for a pair of $\pm x$ tiles (see Figure 3) and also, for a pair of $\pm x^2$ tiles (see Figure 4). Figure 3 illustrates algebra tiles representing a zero-sum pair: $(+x) + (-x) = 0$. Figure 4 illustrates algebra tiles representing a zero-sum pair: $(+x^2) + (-x^2) = 0$. This study is limited to unit tiles representing a zero-sum pair: $(+1) + (-1) = 0$.

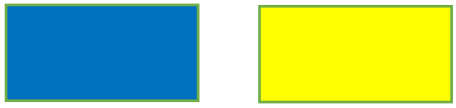

Fig. 3. Zero-sum pair $(+x) + (-x) = 0$

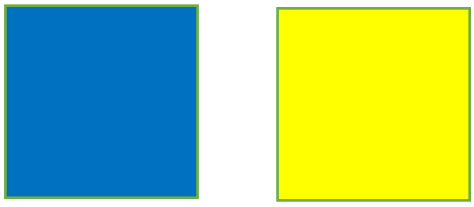

Fig. 4. Zero-sum pair $(+x^2) + (-x^2) = 0$

Research Methodology

The researcher spent four months of duration regarding the preparation of TPD. It began with the selection of the theme, followed by the development of a series of activities based on the theme selected. And lastly, proposal writing (to course facilitator), venue selection, and participants selection. In between, the process also involved constant feedback from the course facilitator and colleagues. Based upon this, the researcher revised planned activities, unless and until it was all right from the side of the course facilitator.

The TPD venue was selected using purposeful sampling and was one of Kathmandu's public schools (host). Actually, the TPD venue was one of the co-facilitators teaching school. Similarly, the participants were selected purposefully from various schools (10) in Kathmandu (through relevant networks of the host school principal). Beforehand, detailed information regarding TPD was informed to other school principals (and mathematics teachers were invited to participate) via phone calls. Therefore, the participants were from the host school and schools of different wards in

Kathmandu, i.e., from diverse wards (10) of Kathmandu. This study involved 22 mathematics teachers (19 female, 3 male) belonging to both public (18) and private (4) schools in Kathmandu, Nepal as participants, who are teaching at various education levels – primary: grade 1-5 (9), lower-secondary: grade 6-8 (6), and secondary: grade 9-12 (7). There were 26 participants, however, four of them did not attend the complete sessions, so they were not considered.

Strategy and Implementation

The TPD was conducted for two days in a series of three sessions – session 1 and session 2 (on the first day), and session 3 (on the second day). And it was guided by social constructivism (Kausar & Deeba, 2021). The researcher acted more like a facilitator (and observer), while the participants participated actively (in a collaborative environment) during the teaching-learning process. Additionally, this study utilized C-R-A as an instructional approach which is a three-stage learning process where students firstly, learn through the use of concrete objects (through touch), followed by a pictorial representation of it (through images), and lastly, through abstract notion/symbol; thus, C-R-A stands for Concrete (C), Representational (R), and Abstract (A) respectively (Witzel, 2005). Studies like Leong et al. (2015), Maccini and Ruhl (2000), and Witzel (2005) have stated C-R-A as an effective approach in terms of employing manipulatives, which in turn, when coupled with algebra tiles can assist students (particularly, with learning disabilities) in improving conceptual understanding of mathematical contents like algebra. Furthermore, Lemonidis et al. (2020) stated that C-R-A is an effective approach for low-achiever students. Moreover, this study referred to the ideas provided by Kennard (2019) about lesson sequence for algebra tiles to BAO on integers.

Session 1

In session 1, firstly, the participants were introduced to the algebra tiles and then were indulged in an activity of construction of algebra tiles.

The participants were encountered with the description of algebra tiles: types (unit/x/x^2) and shape (square/rectangle) associated with it; colors (blue/yellow) and their representation ($+/-$); and lastly, size (smallest/largest). This was conducted in the form of an activity (as a questionnaire) through PowerPoint animation, with the idea of having a two-way interaction between the researcher and the participants (as shown in Figure 5).

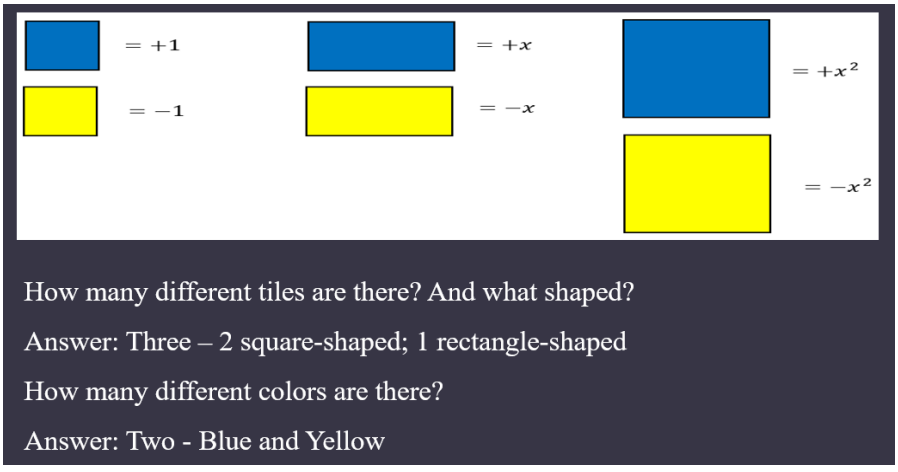

Fig. 5. Introduction to algebra tiles

Fig. 6. Participants constructing algebra tiles

Next, pairs were formed. Then, all the required materials (A4 size blue and yellow color sheet paper, glue, scissor, ruler, pencil, eraser, sharpener, and worksheet) were distributed to each participant and they were instructed to paste (blue and yellow) sheet paper together (perfectly overlapping). Afterward, pairs were instructed to prepare unit algebra tiles of the following dimension: 3 cm × 3 cm. Lastly, the participants were aware of a 'zero-sum pair' concept.

Session 2

In this session, the researcher emphasized on 'C' stage of the C-R-A instructional sequence. Firstly, the session began with instruction (to the participants) to model the following integers using algebra tiles: $(+2)$ and (-3). Participants performed the task with ease.

Then, the session was led towards 'addition of integers.' Participants were aware of the ideas that need to be considered while performing the addition of integers using algebra tiles. For instance; model integers (first and foremost); addition is comprehended as 'combining;' and if there exists a zero-sum pair concept, apply it (Kennard, 2019).

Firstly, the researcher demonstrated: $(+2) + (-1) = +1$ using algebra tiles. Then, participants were asked to do so for the following: (i) $(-2) + (+3) =?$ (ii) $(+3) + (+3) =?$ The researcher moved around the space, asking if anyone had doubts. Participants performed the task with ease. For instance; see figure 7 (provided below).

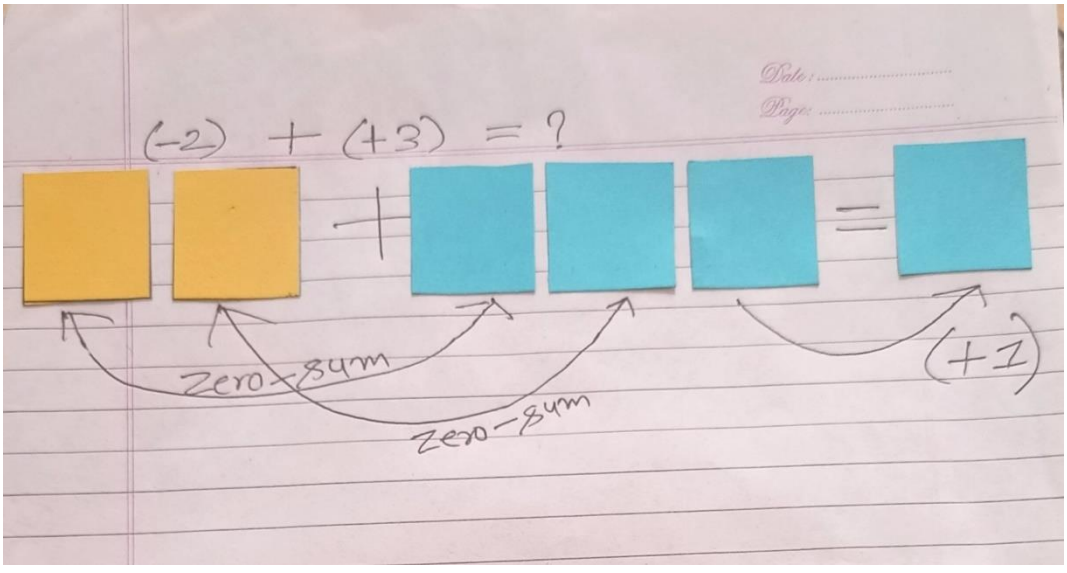

Fig. 7. Solving addition operation on integers using algebra tiles

Next, the session was led towards 'subtraction of integers.' Participants were aware of the ideas that need to be considered while performing subtraction of integers using algebra tiles. For instance; subtraction is comprehended as 'turn-over (flip-over);' turn-over the second integer; and if there exists a zero-sum pair concept, apply it (Kennard, 2019).

Firstly, the researcher demonstrated: $(+2) - (-1) = +3$ using algebra tiles. Then, participants were asked to do so for the following: (i) $(-3) - (-2) =?$ (ii) $(+2) - (+1) =?$ Participants performed the task with ease. For instance; see figure 8 (provided below).

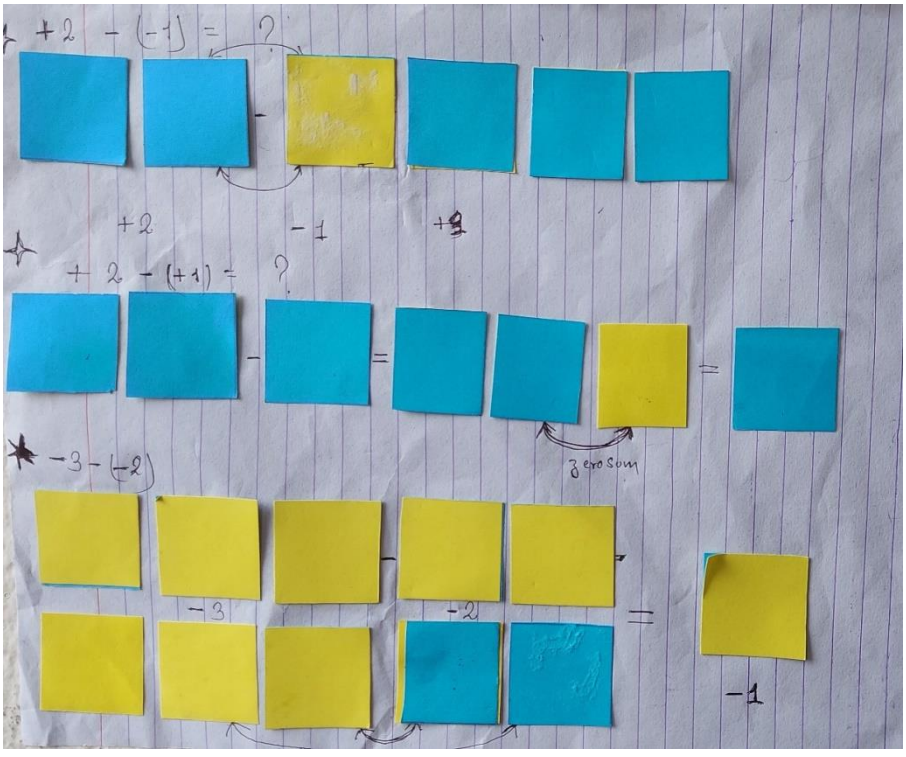

Fig. 8. Solving subtraction operation on integers using

Fig. 9. Participants working enthusiastically

Session 3

This session began the next day. In this session, the researcher emphasized on 'R-A' stages of the C-R-A instructional sequence. The idea was to step up participants to R-A stages, only after making them comfortable with concrete materials (i.e., modeling of integers using algebra tiles).

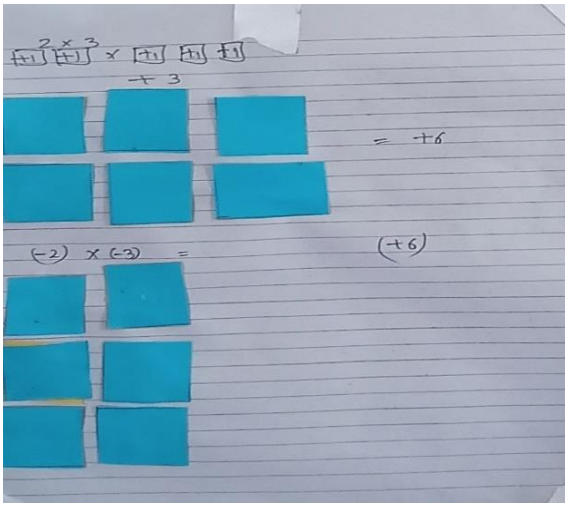

Fig. 10. Solving multiplication operation on integers using algebra tiles

The researcher asked two of the participants (voluntarily) regarding their lucky number, which came out as 1 and 3. Then, the researcher led the session towards the 'multiplication of integers.' Participants were aware of the ideas that need to be considered while performing the multiplication of integers using algebra tiles. For instance; comprehend $(+1) \times (-3)$ as one row and three columns or three rows and one column (considering both as positive integers); then arrange tiles in that row(s) and columns(s) to form a rectangle/square; if there is one negative $(-)$, then turn-over the whole tiles once; if there are two negatives $(-)$, then turn-over the whole tiles twice; finally, the available tiles will give the required value (Kennard, 2019).

Firstly, the researcher demonstrated (and explained): $(+1) \times (-3) = -3$ through the R-A instructional sequence on the whiteboard. Then, participants were asked to do so for the following: (i) $(+2) \times (+3) =?$ (ii) $(-2) \times (-3) =?$ Participants were

assisting each other. Participants performed the task with ease. For instance; see figure 10 (provided below).

Fig. 11. Participants working (and assisting) in a pair

Next, the session was led towards the 'division of integers.' Firstly, participants were aware that algebra tiles come with some limitations and are applicable only for operations with integer values (result). For instance; it is not applicable for the following operation: $(+8) \div (+5) = 1.6$, as here the result is not an integer. Then, participants were aware of the ideas that need to be considered while performing the division of integers using algebra tiles. For instance; the dividend represents the total number of available algebra tiles; the divisor represents either the number of row(s) or column(s) - choose either of them; then arrange tiles in such a way that it forms a rectangle/square (considering both as positive integers); if there is one negative $(-)$, then turn-over the whole tiles once; if there are two negatives $(-)$, then turn-over the whole tiles twice; finally, the other side of rectangle/square so formed will give the required value (Kennard, 2019).

The researcher demonstrated (and explained): $(-6) \div (+2) = -3$ through the R-A instructional sequence on the whiteboard. Then, participants were asked to do so for the following: (i) $(+8) \div (-2) =?$ (ii) $(-8) \div (-2) =?$ For instance; see figure 13 (provided below). A few of the participants were confused regarding the idea of a

divisor. Therefore, the researcher moved around and guided them. Participants did not hesitate to clear their doubts.

Fig. 12. Researcher assisting the participants

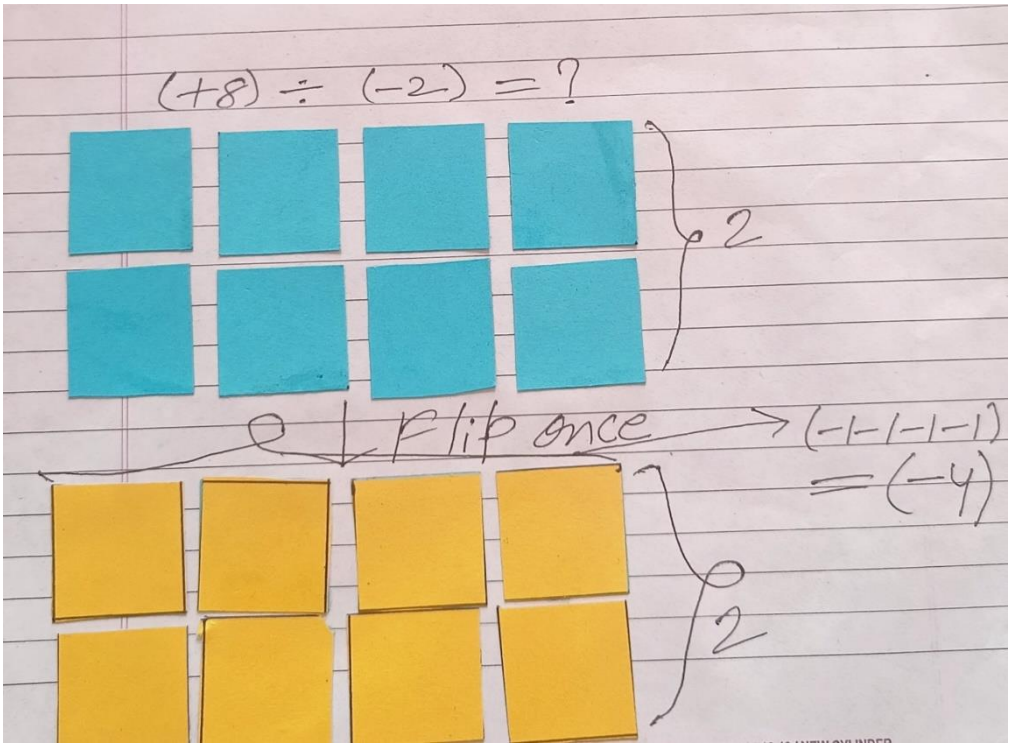

Fig. 13. Solving division operation on integers using algebra tiles

In the end, the reflection form was distributed to the participants consisting of open-ended questions to get their responses (see Appendix - A). Furthermore, participants were asked to share their overall experiences (i.e., reflection on the sessions) verbally which was recorded through the smartphone.

This study employed a qualitative technique, guided by an interpretivism research paradigm (Taylor & Madina, 2011), and triangulation (Burns, 2015). Multiple data sources - participant observations, researcher-participant interaction, and participant worksheets; followed by reflection forms, end-reflection videos, and photos were utilized for obtaining relevant data. The data analysis was based on the synthesis of all data sources - forming three open-ended questions (included in reflection form) as a foundational: (1) What did you (participants) like the most in this TPD session? (2) Are the activities which you have discussed here applicable in your classroom teaching? (3)

Fig. 14. Participant sharing reflection verbally

What are the constraints that you would find to bring these activities inside your classroom? Right after TPD completion, the researcher reflected on - his observation and interaction with participants; meticulously went through each reflection form and end-reflection videos; and lastly, themes were derived.

Results and Findings

The following four themes emerged from the data analysis: (1) the positive influence of algebra tiles, (2) constraints in the implementation of algebra tiles, (3) the

determination to implement algebra tiles, and (4) the appropriate occasion for implementing algebra tiles properly.

Positive Influence of Algebra Tiles on School Teachers'

The data analysis revealed that the use of algebra tiles had a positive influence on the participants, as physical manipulatives (in general) and also regarding operations on integers. The participants were constructing the algebra tiles with pleasure (in session 1). This was evident before the commencement of session 3 as well, when two of the participants reached the TPD venue earlier than the allotted schedule (10:00 A.M.) and immediately asked for materials to construct algebra tiles. They stated, "Dear sir, there is still time to clock 10:00 A.M., so give us materials, and we will prepare algebra tiles." Besides, three of the participants (in reflection form) specifically stated the construction of algebra tiles as the activity they liked the most. For instance; one participant stated that the session I liked the most is making materials. Moreover, one of the 22 participants stated that the use of algebra tiles may lead to the wastage of paper.

In sessions 2 and 3, during the teaching-learning process of performing BAO on integers using algebra tiles, participants illustrated a sheer amount of enthusiasm to perform the activities involved in it. This was reflected in the reflection form (and in the end-reflection video as well), where four of the participants stated the process of performing operations on integers using algebra tiles as the activity they liked extremely. One of the participants stated that he/she felt happy to know that through the assistance of algebra tiles, one can perform BAO on integers. Another participant stated that "students can easily understand the concepts by using algebra tiles." Besides, these two, one participant stated joy in having the opportunity to learn - addition, subtraction, and the multiplication of two negative integers, using algebra tiles. Furthermore, one participant (in the end-reflection video) stated that she found the idea of multiplication of two negative integers effective, which previously she was struggling to make students understand. Moreover, one of the 22 participants stated that "maybe not every student will get the concept as everyone has a different understanding level."

The highlight of session 3 was that participants were performing the activities even during the lunch break. The venue environment was buzzing with their joy. Even some of the participants were eager to take their worksheets (along with them) to their homes, and on interaction was found that they were eager to show it to their students and even to their children. One of the participants asked, "Dear sir, could we take our

worksheet along with us to our home?" Following her, other participants also began to ask. That initial participant further stated, "I will implement these activities in my home (to my children)." In response to that one (nearby) participant stated, "My students are going to love these activities."

Moreover, one of the participants (in the end-reflection video) even resembled the sessions with one of the Bollywood movies named "Taare Zameen Par." And particularly, talked about the main character of the movie: 'Ishaan (Darsheel Safary) – the little boy who was suffering from dyslexia (difficulty in reading).' She stated that "the sessions constantly reminded her of Ishaan regarding how these sessions could benefit such kinds of students."

In conclusion, the data analysis revealed that the participants were able to solve problems based on BAO on integers using algebra tiles (as physical manipulatives) with ease, except with little difficulty in division (÷).

Constraints in the Implementation of Algebra Tiles

The data analysis revealed that the participants stated some kind of concerns that can act as a constraint while implementing algebra tiles properly in their mathematics classrooms. The prime concerns are as follows: – (1) material cost, (2) material availability, (3) activity duration, and (4) classroom management.

Material Cost

Three of the participants stated materials cost as a constraint. The first participant stated that algebra tiles can be implemented in his/her classroom, but will be a little costlier. The second participant stated that "the required materials might not be affordable to everyone (students)." The third participant specifically stated, "Economically as a constraint."

Material Availability

Eighth of the participants stated materials availability as a constraint. One of the participants stated that "the possible problem that can be faced would be the availability of colorful papers." Another participant stated that "required materials may not be available." While other participants stated, insufficient/lack of materials as a constraint. For instance; one participant stated that there might be a shortage of materials for applying these activities using the C-R-A method in the classroom.

Activity Duration

Tenth of the participants stated the duration required to perform activities properly as a constraint (which was reflected in the end-reflection video as well). One of the participants stated that "activities required a lot of time which may not match with the given classroom teaching hours." Another participant stated that "if I apply these activities inside my classroom, students need some more extra time so that they can get proper knowledge through the C-R-A method." Five other participants stated the activities involved as time-consuming, while the other three participants stated a lack of time. For instance; one of the participants stated that "activities are applicable in the classroom, however, it is time-consuming." Another participant stated, there might be a shortage of time to apply these activities properly in my classroom. Moreover, one participant (in the end-reflection video) stated that inadequate time might be a challenge in taking these activities to the classroom.

Classroom Management

Three of the participants stated the task of managing the classroom (while performing activities) as a constraint. The first participant stated that "students can talk to each other, thus making class disturbing." The second participant stated that it seems to be hard to control the classroom; additionally, if I would not be able to make the concepts clearer, then problems might arise more. The third participant specifically stated, "Classroom management as a constraint."

Determination to Implement Algebra Tiles

The data analysis revealed that despite some constraints, participants illustrated the determination to implement algebra tiles in their classrooms. One of the participants stated that "teaching materials is a constraint, but it is not a big problem, I can manage it." Another participant stated that "due to time-consuming, it will be hard to implement in all units of curriculum, however doing it through model illustration would be appropriate." One participant (in the end-reflection video) stated "Yes, initially there would be a difficulty, however, they are the teachers, they need to be well prepared, and they will make students learn!"

Appropriate Occasion for Implementing Algebra Tiles Properly

The participants also offered some alternatives to implement algebra tiles properly. Two of the participants suggested "Book Free Day" while another two participants suggested "remedial teaching" (relative to low-achiever students) as the

most appropriate occasion to implement algebra tiles properly. For instance; one participant specifically stated "No Book Day." Another participant stated that it is more applicable in remedial teaching. Book Free Day here, refers to an initiative introduced (2023, April 27) by Kathmandu Metropolitan City (KMC), where students go to school without books and bags every Friday intending to develop life skills in a joyful environment (The Kathmandu Post, 2023).

Discussion

The findings of this study revealed that the participants were fascinated by the use of algebra tiles (as physical manipulatives). They were engaged heavily (Tjandra, 2023) and had a pleasant experience using algebra tiles (Garzón & Bautista, 2018; Pande, 2019). As the session progressed, there seemed to be an increment in the readiness of the participants to learn (Khalid & Embong, 2020). As a result, participants seemed cheerful, participated actively, showed curiosity, and thoroughly enjoyed the teaching-learning process, following the findings of studies such as Jaisi (2020), Khalid and Embong (2020), Pande (2019), and Rini (2022).

Furthermore, it is apparent that the use of algebra tiles (coupled with C-R-A) had a positive impact on the participants concerning the conceptual understanding of operations on integers, following the findings of Khalid and Embong (2020). That is why, participants seemed to be ready to apply algebra tiles even to their children (at home); termed the activities involved in the teaching-learning process as easier, practical, innovative, and joyful; and learning through it as long-lasting/sustainable. Additionally, indicators like good engagement, ability to solve BAO on integers using algebra tiles, and accessibility of algebra tiles to learners with disability signify that algebra tiles are effective in learning mathematics (Wondo & Meke, 2021). Therefore, it seemed that (in the participants' perspective) the use of algebra tiles is effective (particularly, in the multiplication of two negative integers) and beneficial for the students (particularly, those with learning disabilities), following the concluding remarks of Klu et al. (2023) – they termed the use of physical manipulatives (in general) as 'successful' for all pre-tertiary levels; and also, the results of Tjandra (2023). Consequently, this suggests that somehow the participants from various education levels (primary – secondary) viewed algebra tiles (coupled with C-R-A) as a valuable teaching aid for mathematics teachers (Abdul-Karim et al., 2023). Hence, suggesting that school mathematics teachers need to employ it in their teaching practices.

Based on the above discussion, it can be inferred that participants envision the use of algebra tiles as applicable in their respective mathematics classrooms. They believed that algebra tiles are appropriate for their mathematics classroom teaching. However, there seemed to be some concerns, primarily concerning cost (Amelia et al., 2022), availability (Amelia et al., 2022), time, and management; particularly concerning regular use, completion of syllabus, classroom with different learning needs, and large classroom strength. It seemed that for the participants it is difficult to implement the activities properly - with limited budgets (Tjandra, 2023); little availability; within the stipulated period of 40 minutes (of classroom teaching); and scenarios of chaos that might arise in between the teaching-learning process. The higher the number of students, the higher will be - the cost (and requirement) of materials; and the degree of difficulty in managing the classroom (Rini, 2022). It might seem that all these demand sufficient money, resources, time, and effort (Tjandra, 2023). Hence, suggesting that insufficient of it can truly hinder an application of algebra tiles to its full potential in mathematics teaching. Hence, the above discussion suggests the need to provide sufficient resources and proper training to the teachers - to effectively use algebra tiles, to be able to adapt algebra tiles for different learning needs (Tjandra, 2023), and in general to uplift their self-efficacy.

Despite all these challenges, participants seemed to be motivated enough (Jaisi, 2020; Khalid & Embong, 2020) and were determined to implement algebra tiles in their classrooms. As a result, participants viewed ‘Book Free Day’ and ‘remedial teaching’ as appropriate occasions for implementing algebra tiles properly. It might seem that it will provide them with ample time to implement (and execute) algebra tiles effectively – overcoming large classroom sizes and meeting the diverse learning needs of the classroom (through adequate attention to each student). Thus, suggesting both as days, where the potential of algebra tiles (as physical manipulatives) can be maximized.

Conclusion

This study found that the participants had a positive outlook towards the use of algebra tiles (as physical manipulatives) and believed that its application can assist students (particularly, those with learning disabilities) in developing a conceptual understanding of BAO on integers - notably concerning recurring issue - the multiplication of two negative integers. Furthermore, they also believed that the implementation of algebra tiles in their classrooms would not be straightforward, particularly regularly (and to large classroom strength); primarily due to constraints

related to cost, availability, time, and management. However, despite these constraints, participants were motivated enough and were determined to implement algebra tiles in their classrooms, resulting in 'Book Free Day' and 'remedial teaching' as the most appropriate occasions for implementing algebra tiles properly.

Limitation and its Implication

The sample employed in this study does not truly represent all schools in KMC. Therefore, this study cannot suggest that its findings are generalizable to every school. This study inquires about the perspectives of school mathematics teachers, before actually implementing algebra tiles in their mathematics classrooms. Therefore, future studies (in the context of Nepal) could be done regarding inquiries about the perspectives of school mathematics teachers, after the implementation (and execution) of algebra tiles in their mathematics classrooms.

However, even with the limitations, this study could provide some insights about physical manipulatives in mathematics teaching. Additionally, this study could motivate school mathematics teachers to apply manipulatives (like algebra tiles), and also to employ C-R-A as a sequence of instruction in their mathematics teaching.

References

Abdul-Karim, H., Kasimu, O., Rahaman, A. A., Kanimam, Y. S., Imoro, M., & Dokurugu, M. E. (2023). Assessing the impact of algebra tiles as visual and manipulative aids on students' algebraic understanding. *American Journal of Educational Research*, *11*(10), 705-711. http://dx.doi.org/10.12691/education-11-10-9

Amelia, E., Attalina, S. N. C., & Widiyono, A. (2022). Pengaruh model kooperatif tipe stad berbantuan media manipulatif terhadap hasil belajar siswa di sekolah dasar. *Jurnal Pendidikan Dan Konseling*, *4*(3), 542-548. https://doi.org/10.31004/jpdk.v4i3.4341

Bouck, E. C., & Park, J. (2018). A systematic review of the literature on mathematics manipulatives to support students with disabilities. *Education and Treatment of Children*, *41*(1), 65-106. https://doi.org/10.1353/etc.2018.0003

Burns, A. (2015). Action research. In J. D. Brown & C. Coombe (Eds.), *The Cambridge guide to research in language teaching and learning intrinsic eBook* (pp. 187-204). Cambridge.

Curriculum Development Centre. (2020). *Basic education curriculum, grade (6-8).* Retrieved from https://moecdc.gov.np

Curriculum Development Centre. (2021). *Secondary education curriculum grade (9-10).* Retrieved from https://moecdc.gov.np

Drushlyak, M. G., Semenikhina, O. V., Proshkin, V. V., & Sapozhnykov, S. V. (2021). Training pre-service mathematics teacher to use mnemonic techniques. *Journal of Physics: Conference Series*, *1840*(1), 1-13. https://doi.org/10.1088/1742-6596/1840/1/012006

Education Review Office (ERO). (2020). *Report on national assessment of student achievement (NASA) 2019*.

Education Review Office (ERO). (2022). *Report on national assessment of student achievement (NASA) 2020*.

Fuadiah, N. F., Suryadi, D., & Turmudi. (2017). Some difficulties in understanding negative numbers faced by students: A qualitative study applied at secondary schools in Indonesia. *International Education Studies*, *10*(1), 24-38. https://doi.org/10.5539/ies.v10n1p24

Garzón, J., & Bautista, J. (2018). Virtual algebra tiles: A pedagogical tool to teach and learn algebra through geometry. *Journal of computer assisted learning*, *34*(6), 876-883. https://doi.org/10.1111/jcal.12296

Heddens, J. W. (1997). Improving mathematics teaching by using manipulatives. Retrieved from https://idoc.pub/download/improving-mathematics-teaching-by-using-manipulativesdocx-d49ove981049

Hidayah, I., Dwijanto, & Istiandaru, A. (2018). Manipulatives and question series for elementary school mathematics teaching on solid geometry. *International Journal of Instruction*, *11*(3), 649-662.

Ikawati, O. N., & Kowiyah, K. (2021). Visual, auditory, and kinesthetic learning model on the mathematics problem solving ability. *Desimal: Jurnal Matematika*, *4*(1), 13-20. http://dx.doi.org/10.24042/djm.v4i1.7362

Jaisi, R. P. (2020). *Effectiveness of manipulative materials in teaching mathematics* [Unpublished master dissertation]. Tribhuvan University.

Kausar, H., & Deeba, F. (2021). Social constructivism: A new paradigm in teaching and learning environment. *Perennial Journal of History*, *2*(2), 403-421. https://doi.org/10.52700/pjh.v2i2.86

Kennard, V. (2019). *Algebra tiles learning sequence*. Calculate. Retrieved from https://calculate.org.au/wp-content/uploads/sites/15/2019/07/lesson-sequence-for-algebra-tiles-final.pdf

Khalid, M., & Embong, Z. (2020). Emphasizing concrete representation to enhance students' conceptual understanding of operations on integers. *Turkish Journal of Computer and Mathematics Education*, *11*(3), 762-773. https://doi.org/10.16949/turkbilmat.775605

Klu, T. K., Assan, F. K., Maanu, V., & Atta, S. O. A. (2023). An investigation of the use of physical manipulatives to enhance the conceptual understanding of operations on fraction among pre-service teachers. *European Centre for Research Training and Development UK*, *4*(2), 1-11. https://doi.org/10.37745/bjmas.2022.0122

Lafay, A., Osana, H. P., & Valat, M. (2019). Effects of interventions with manipulatives on immediate learning, maintenance, and transfer in children with mathematics learning disabilities: A systematic review. *Education Research International*, *2019*. https://doi.org/10.1155/2019/2142948

Larbi, E., & Okyere, M. (2014). Algebra tiles manipulative and gender differences in learning and achievement in mathematics: A case of Sunyani west municipality. *Journal of Education and Practice*, *5*(38), 1-7.

Lemonidis, C., Anastasiou, D., & Iliadou, T. (2020). Effects of Concrete-Representational-Abstract instruction on fractions among low-achieving sixth-grade students. *Effective Journal of the University of Patras UNESCO Chair*, *7*(2), 43-57.

Leong, Y. H., Ho, W. K., & Cheng, L. P. (2015). Concrete-Pictorial-Abstract: Surveying its origins and charting its future. *The Mathematics Educator*, *16*(1), 1-18.

Maccini, P., & Ruhl, K. L. (2000). Effects of a graduated instructional sequence on the algebraic subtraction of integers by secondary students with learning disabilities. *Education and Treatment of Children*, 465-489.

Makonye, J. P., & Fakude, J. (2016). A study of errors and misconceptions in the learning of addition and subtraction of directed numbers in grade 8. *SAGE Open*, *6*(4), 1-10.

Manandhar, N. K., Pant, B. P., & Dawadi, S. D. (2022). Conceptual and procedural knowledge of students of Nepal in Algebra: A mixed method study. *Contemporary Mathematics and Science Education*, *3*(1), ep22005. https://doi.org/10.30935/conmaths/11723

Mink, D. V. (2009). *Strategies for teaching mathematics*. Shell Education Publishing, Inc.

Pande, M. N. (2019). *The effectiveness of manipulative materials in teaching mathematics at primary level* [Unpublished master dissertation]. Tribhuvan University.

Panthee, D. (2023). Teachers' professional development at public campuses in Nepal: Policies and practices. *Kaladarpan कलादर्पण*, *3*(1), 142-151. https://doi.org/10.3126/kaladarpan.v3i1.55268

Raza, J. M. (2022). Role of arithmetic principles and operations in understanding students' mathematics performance. *International Journal of Research Studies in Education*, *11*(12), 89-102. https://doi.org/10.5861/ijrse.2022.326

Rini, D. S. (2022). Algebra tiles as physical manipulatives to support Indonesian students' understanding of linear equations of one variable. *Southeast Asian Mathematics Education Journal*, *12*(2).

Shahi, B. B. (2015). *Effect of material on mathematics achievement in algebra* [Unpublished master dissertation]. Tribhuvan University.

Sullah, R. M., Ismail, N. H., & Abdullah, A. H. (2017). A comparison between virtual and physical manipulatives in geometry learning for standard 2 mathematics. *Man in India*, *97*(17), 235-247.

Taylor, P.C., & Medina, M. (2011). Educational research paradigms: From positivism to pluralism. *College Research Journal*, *1*(1), 1-16.

The Kathmandu Post. (2023, April 27). *Textbook-free day initiative welcomed but also doubted*. Retrieved from https://kathmandupost.com/kathmandu/2023/04/27/textbook-free-friday-initiative-welcomed-but-also-doubted

Tjandra, C. (2023). Effectiveness of using manipulatives in mathematics teaching in inclusive education programs in an elementary school. *Dharmas Education Journal*, *4*(1), 168-178. https://doi.org/10.56667/dejournal.v4i1.944

Toh, T. S., Tengah, K. A., Shahrill, M., Tan, A., & Leong, E. (2017). The flipped classroom strategy: The effects of implementation at the elementary school level mathematics lessons. *Proceeding of the 3rd International Conference on Education*, *Kuala Lumpur*, *Malaysia*, *3*, 186-197. https://doi.org/10.17501/icedu.2017.3120

Torbeyns, J., Schneider, M., Xin, Z., & Siegler, R. S. (2015). Bridging the gap: Fraction understanding is central to mathematics achievement in students from three different continents. *Learning and Instruction*, *37*, 5-13.

Watt-Douglas, T., & George, L. (2021). Investigating the impact of using manipulatives on grade 5 Jamaican students' mathematics achievement: An action research. *Caribbean Journal of Education*, *42*, 1-39. http://dx.doi.org/10.46425/c142123702

Widjaja, W., Stacey, K., & Steinle, V. (2011). Locating negative decimals on the number line: Insights into the thinking of pre-service primary teachers. *The Journal of Mathematical Behavior*, *30*(1), 80-91. https://doi.org/10.1016/j.jmathb.2010.11.004

Witzel, B. S. (2005). Using CRA to teach algebra to students with math difficulties in inclusive settings. *Learning Disabilities: A Contemporary Journal*, *3*(2), 49-60.

Wondo, M. T. S., & Meke, K. D. P. (2021). Analisis pengaruh sikap percaya diri siswa dalam pembelajaran Matematika Menggunakan model PBL berbantuan bahan manipulatif. *Jupika: Jurnal Pendidikan Matematika*, *4*(1), 11-21. https://doi.org/10.37478/jupika.v4i1.894

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Appendix - A
Sample of Participant's Reflection Form

1. What did you like most in this TPD session?
यो शिक्षण सीप वृद्धि विकास कार्यक्रममा तपाईंलाई कुन कुरा एकदमै राम्रो लाग्यो ? किन ?

यो शिक्षण सीप वृद्धि विकास कार्यक्रम मलाई धेरै नै राम्रो लाग्यो किन भने यसले गर्दा बच्चाहरुले अझ बढि Practically बुझ्न सजिलो हुन्छ जस्तो लाग्छ। यसले गर्दा छिटो र छरितो तरिकाबाट बुझ्न सकिन्छ।

2. Are the activities which you have discussed here applicable in your classroom teaching?
यो कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

यस विधि बाट हामीले सजिलैसंग शिक्षणमा प्रयोग गर्न सक्छौं किन भने हामीले सजिलो तरिकाबाट छिटो बुझाउन र बुझ्न सक्छौं। यसले गर्दा बच्चाहरुमा longlasting हुन्छ जस्तो लाग्छ।

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंका कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

यस विधी अनुसार शिक्षण क्रियाकलापमा कक्षामा प्रयोग गर्दा सामानको थोरै अभाव हुन सक्छ कि जस्तो लाग्छ यसले खासै असर पर्दैन होला।

1. What did you like most in this TPD session?
यो शिक्षण सीप वृद्धि विकास कार्यक्रममा तपाईंलाई कुन कुरा एकदमै राम्रो लाग्यो ? किन ?

कागजको बिभिन्न आकृती काटेर गर्न पाउदा रमाइलो भयो।

2. Are the activities which you have discussed here applicable in your classroom teaching?
यो कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

राम्रो सँग सकिन्छ।

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंका कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

कतिपय बच्चालाई बुझाउन समय लाग्न सक्छ।

1. What did you like most in this TPD session?
यो शिक्षण सीप वृद्धि विकास कार्यक्रममा तपाईंलाई कुन कुरा एकदमै राम्रो लाग्यो ? किन ?

सीप विकास वृद्धि को लागि राम्रो कार्य। सिक्ने मौका पाइयो। Tiles को प्रयोगविधि बाट सजिलो तरीकाले सिकाउने कुरा बढी प्रभावकारी भयो

2. Are the activities which you have discussed here applicable in your classroom teaching?
यो कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

सकिन्छ किनभने यो विधिबाट रमाइलो तरीकाले प्रयोगात्मक way अपनाएर सिकाउन सकिन्छ।

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंका कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

समस्या त आउँछ सबै बच्चाहरुलाई ध्यान दिन गाह्रो हुन्छ तर पालैपालो गरेर गर्न लगाइन्छ।

1. What did you like most in this TPD session?
यो शिक्षण सीप वृद्धि विकास कार्यक्रममा तपाईंलाई कुन कुरा एकदमै राम्रो लाग्यो ? किन ?

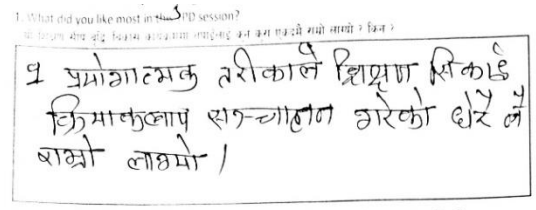
Helps the students to learn by using algebra tiles. Students can easily understand the concept by using tiles.

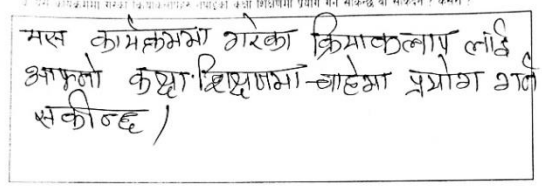
2. Are the activities which you have discussed here applicable in your classroom teaching?
यो कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

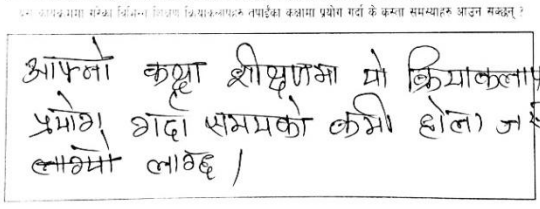
Yes, it is applicable in our classroom or teaching learning process. However it can be more applicable in remedial teaching

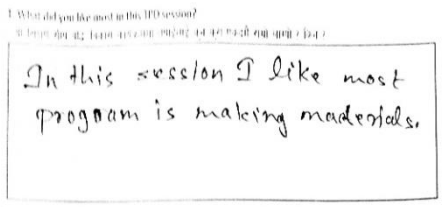
3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंका कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

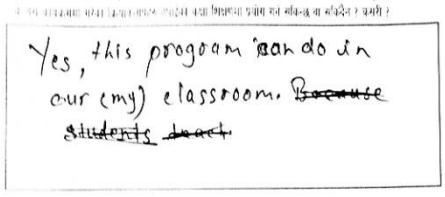
→ Insufficient resources or materials
→ time management
→ difficult to use in day to day class.

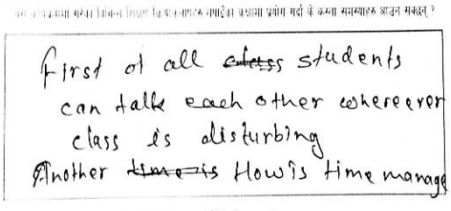

1. What did you like most in this TPD session?
१ प्रयोगात्मक तरीकाले शिक्षण सिकाई क्रियाकलाप सञ्चालन गरेको हेर्न पाएको लाग्यो ।

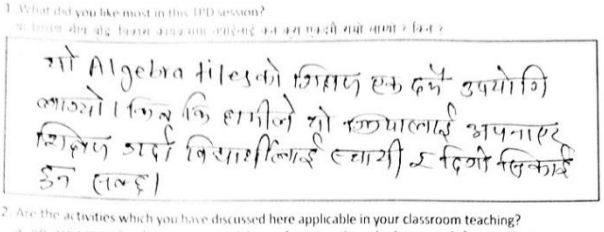

2. Are the activities which you have discussed here applicable in your classroom teaching?
सबै कार्यक्रममा गरेका क्रियाकलाप लाई आफ्नो कक्षा शिक्षणमा चाहेमा प्रयोग गर्न सकीन्छ ।

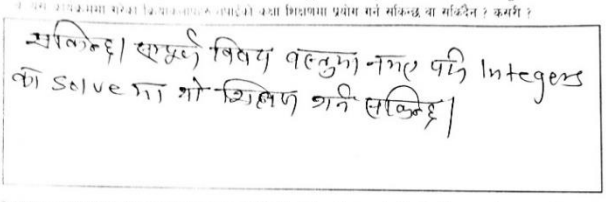

3. What are the constrained that you would find to bring these activities inside your classroom?
आफ्नो कक्षा शिक्षणमा यो क्रियाकलाप प्रयोग गर्दा समयको कमी होला जस्तो लाग्छ ।

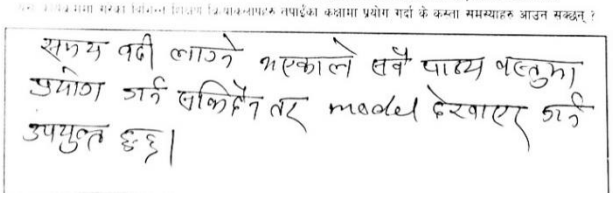

1. What did you like most in this TPD session?
In this session I like most progoam is making madentals.

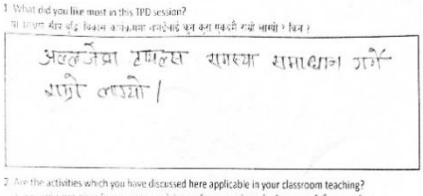

2. Are the activities which you have discussed here applicable in your classroom teaching?
Yes, this progoam can do in our (my) classroom. ~~Because students don't~~

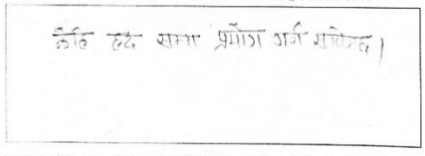

3. What are the constrained that you would find to bring these activities inside your classroom?
First of all ~~class~~ students can talk each other whereever class is disturbing Another ~~time is~~ How is time manage

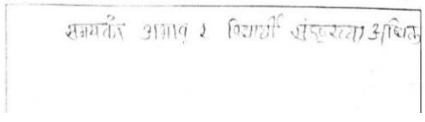

1. What did you like most in this TPD session?
यो Algebra tiles को शिक्षण एक धेरै उपयोगि लाग्यो । किन कि यसबाट हामीले यो कक्षाकोठालाई आफ्नाहरु शिक्षण गर्दा विद्यार्थीलाई बुझाउन र दिएको क्रियाकलाप दिन सजिलो हुन्छ ।

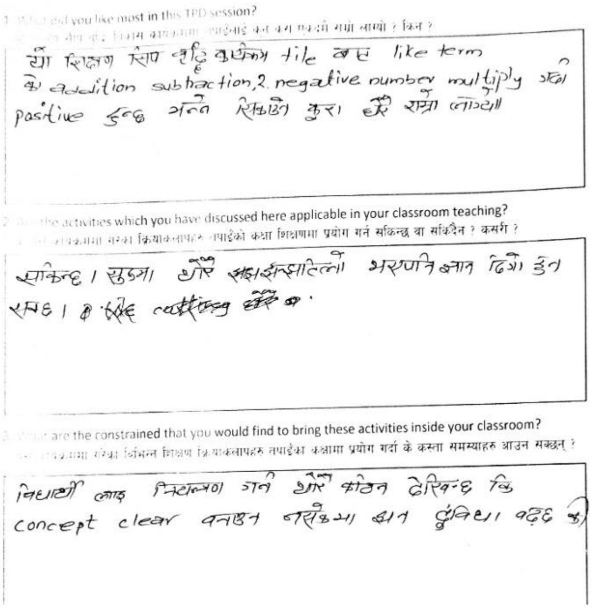

2. Are the activities which you have discussed here applicable in your classroom teaching?
सबैजसो विषय वस्तुका लागि पनि Integers को solve गर्न यो शिक्षण गर्न सकिन्छ ।


3. What are the constrained that you would find to bring these activities inside your classroom?
समय पनि लाग्ने भएकाले सबै पाठ्य वस्तुका प्रयोग गर्न सकिदैन तर model देखाएर गर्न उपयुक्त हुन्छ ।


1. What did you like most in this TPD session?
अल्जेब्रा टायलेस समस्या समाधान गर्ने राम्रो लाग्यो ।


2. Are the activities which you have discussed here applicable in your classroom teaching?
सबै हरु सजाय प्रयोग गर्न सकिन्छ ।


3. What are the constrained that you would find to bring these activities inside your classroom?
समयको अभाव । विद्यार्थी संख्या अधिक



1. What did you like most in this TPD session?
यो तालिममा तपाईंलाई कुन कुरा सबैभन्दा राम्रो लाग्यो ? किन ?

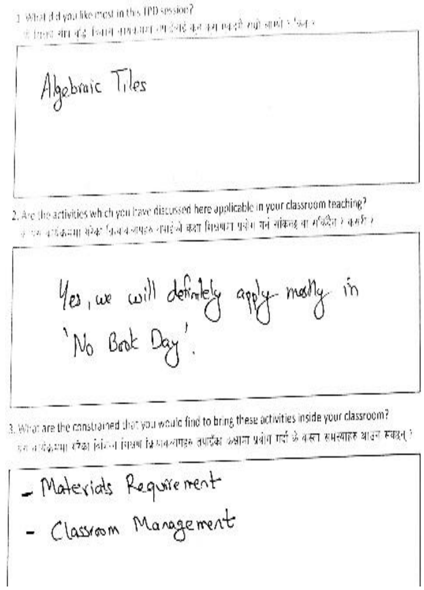
यो शिक्षण सिप वृद्धि कार्यक्रम tile बाट like term को addition subtraction, 2. negative number multiply गर्दा positive हुन्छ भन्ने सिकेको कुरा धेरै राम्रो लाग्यो

2. Are the activities which you have discussed here applicable in your classroom teaching?
यस कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

सकिन्छ । सुरुमा थोरै [illegible] भएपनि [illegible] हुन सक्छ । [illegible] cutting [illegible]

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंको कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

विद्यार्थी लाई नियन्त्रण गर्न थोरै कठिन देखिन्छ कि concept clear बनाउन नसक्दा झन दुविधा बढ्छ कि



1. What did you like most in this TPD session?
यो तालिममा तपाईंलाई कुन कुरा सबैभन्दा राम्रो लाग्यो ? किन ?

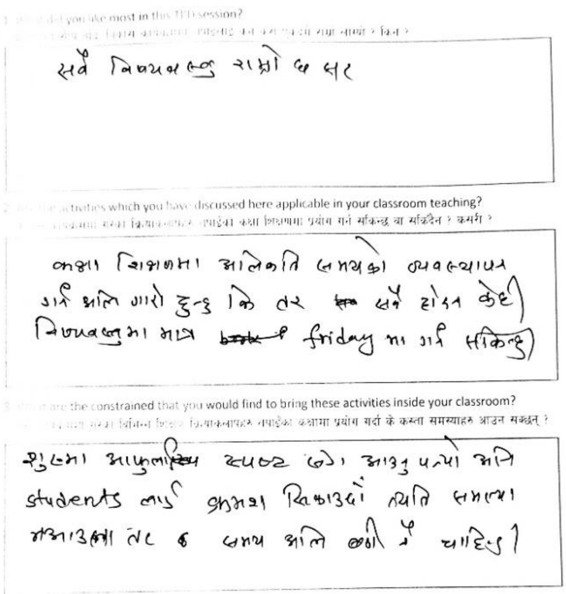
Algebraic Tiles

2. Are the activities which you have discussed here applicable in your classroom teaching?
यस कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

Yes, we will definitely apply mostly in 'No Book Day'.

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंको कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

- Materials Requirement
- Classroom Management



1. What did you like most in this TPD session?
यो तालिममा तपाईंलाई कुन कुरा सबैभन्दा राम्रो लाग्यो ? किन ?

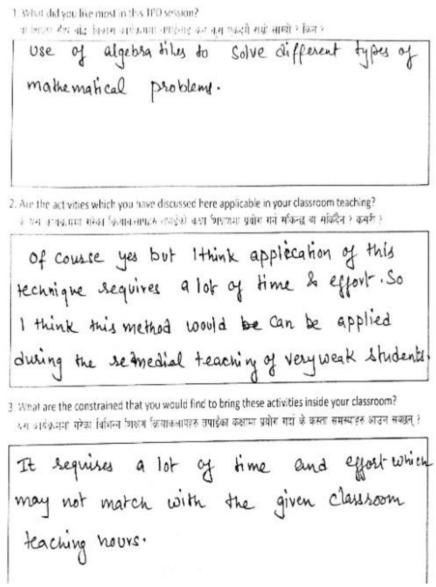
सबै विषयवस्तु राम्रो छ सर

2. Are the activities which you have discussed here applicable in your classroom teaching?
यस कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

कक्षा शिक्षणमा आलेकारि समयको व्यवस्थापन गर्न अलि गाह्रो हुन्छ कि तर सबै होइन केही विषयवस्तुमा मात्र friday मा गर्न सकिन्छ

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंको कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

सुरुमा आफूलाई स्पष्ट हुनुपर्यो अनि students लाई राम्ररी सिकाउँदा त्यति समस्या नआउला तर समय अलि बढी नै चाहिन्छ ।



1. What did you like most in this TPD session?
यो तालिममा तपाईंलाई कुन कुरा सबैभन्दा राम्रो लाग्यो ? किन ?

Use of algebra tiles to solve different types of mathematical problems.

2. Are the activities which you have discussed here applicable in your classroom teaching?
यस कार्यक्रममा गरेका क्रियाकलापहरु तपाईंको कक्षा शिक्षणमा प्रयोग गर्न सकिन्छ वा सकिँदैन ? कसरी ?

Of course yes but I think application of this technique requires a lot of time & effort. So I think this method would be can be applied during the remedial teaching of very weak students.

3. What are the constrained that you would find to bring these activities inside your classroom?
यस कार्यक्रममा गरेका विभिन्न शिक्षण क्रियाकलापहरु तपाईंको कक्षामा प्रयोग गर्दा के कस्ता समस्याहरु आउन सक्छन् ?

It requires a lot of time and effort which may not match with the given classroom teaching hours.