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DEVELOPING ALGEBRAIC CONCEPTS THROUGH INTERACTIVE APPLICATIONS: THE USE OF GEOGEBRA, WORDWALL, LEARNINGAPPS, AND KAHOOT IN PRIMARY EDUCATION

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ABSTRACT

This theoretical review examines the instructional use of GeoGebra, Wordwall, LearningApps, and Kahoot to develop early algebraic concepts in primary education. It discusses the transition from arithmetic to relational and generalized thinking and proposes a coordinated digital-learning framework for teaching patterns, equality, unknown quantities, expressions, and elementary equations. The applications are considered according to their distinct pedagogical affordances: dynamic mathematical representations, retrieval and classification activities, interactive matching and sequencing, and formative assessment with immediate feedback. An illustrative teaching sequence, selection criteria, assessment framework, and practical limitations are provided. The article does not present experimental results and does not claim that digital tools independently cause improved achievement. It concludes that interactive applications may support algebraic reasoning when activities are aligned with learning objectives, include explanation and reflection, and are integrated with teacher-guided discussion and non-digital practice.

Keywords: early algebra; primary mathematics; GeoGebra; Wordwall; LearningApps; Kahoot; interactive learning; digital pedagogy; formative assessment

1. INTRODUCTION

Algebraic thinking begins before the formal study of algebra. In primary education, pupils can explore number relationships, repeated patterns, properties of operations, unknown quantities, and the meaning of equality. These ideas prepare learners to reason about mathematical structures rather than relying solely on isolated calculations.

Digital learning environments provide opportunities to present, manipulate, compare, and discuss mathematical representations. However, the educational contribution of an application depends on how the teacher designs the activity and connects it to the underlying concept.

This article examines four widely used interactive platforms—GeoGebra, Wordwall, LearningApps, and Kahoot—and proposes a theoretical framework for their purposeful integration into early algebra instruction.

2. THEORETICAL FOUNDATIONS OF EARLY ALGEBRA

Early algebra emphasizes the generalization of arithmetic relationships, the use of representations, and reasoning about equality and variation [1, 2]. Children can investigate why 4 + 7 equals 7 + 4, extend a growing visual pattern, or determine a missing value in an equation before they encounter formal algebraic notation.

From a constructivist perspective, learners benefit from tasks in which they actively test and refine ideas. Digital manipulation can support such exploration when the teacher asks pupils to explain patterns, identify invariants, and justify conclusions.

The National Research Council describes mathematical proficiency as involving conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive

disposition [3]. Interactive activities should therefore cultivate reasoning and communication, not only rapid response or game performance.

Multimedia learning theory further suggests that clear visual representations and well-paced guidance are important for managing cognitive demands [4]. The choice of platform must be subordinated to the mathematical objective.

3. PEDAGOGICAL ROLES OF THE FOUR APPLICATIONS

GeoGebra provides dynamic mathematical representations. At an age-appropriate level, a teacher may use sliders, number lines, or visual models to illustrate how two quantities change together, how equality is maintained, or how a pattern grows. Because its interface can be complex for younger pupils, carefully prepared teacher-led activities may be preferable to unrestricted exploration.

Wordwall supports interactive matching, sorting, quizzes, and other reusable activity formats. It may be used to classify true and false equations, match verbal statements with expressions, or identify the next element in a pattern. The teacher should follow a game with explanation so that correctness is not mistaken for understanding.

LearningApps allows the creation of interactive matching, ordering, grouping, and cloze activities. For example, pupils can pair a visual balance model with an equation or sequence the steps used to solve a one-step equation. The educational value depends on the quality of the content and the feedback provided.

Kahoot can facilitate whole-class questioning and rapid formative checks. It can help identify misconceptions about equality, unknowns, and operation properties. Time pressure and competitive scoring may disadvantage some learners; thoughtful pacing and discussion after each question are therefore essential.

4. COMPARATIVE INSTRUCTIONAL FRAMEWORK

The platforms should not be treated as interchangeable. GeoGebra is particularly relevant when the goal is to explore a mathematical relationship dynamically. Wordwall and LearningApps are useful for structured practice, classification, and representation matching. Kahoot is useful for collecting rapid responses and initiating discussion of common errors.

An instructional sequence may begin with a visual investigation in GeoGebra, continue with representation matching in LearningApps, consolidate distinctions using Wordwall, and conclude with a low-stakes Kahoot check. This order is illustrative rather than mandatory.

At every stage, the teacher should require pupils to verbalize or record the mathematical idea. A digital correct answer is evidence of task performance but does not necessarily establish conceptual mastery.

5. MODEL LESSON: UNDERSTANDING EQUALITY AND UNKNOWN QUANTITIES

The learning objective is for pupils to interpret the equals sign as a relationship and solve simple equations with one unknown. The lesson begins with the question: “Is $6 + 4 = 7 + 3$ true? Explain without calculating everything twice.” This invites relational thinking.

In GeoGebra, the teacher displays two collections whose sizes can be adjusted. Pupils predict what change is needed to preserve equality. A second task introduces $x + 3 = 10$ using a balance-style visual representation.

In LearningApps, pupils match three representations of the same relationship: a picture, a sentence (“a number plus three equals ten”), and the symbolic equation $x + 3 = 10$. The teacher asks why the matches are valid.

In Wordwall, pupils sort statements such as 5 + 2 = 7, 5 + 2 = 6 + 1, and 5 + 2 = 8 into true and false categories, explaining their choices. The lesson ends with a short Kahoot check in which pupils select the missing number and identify an incorrect reasoning step.

After the digital activities, pupils solve and explain two problems on paper. This final step helps the teacher determine whether understanding transfers beyond the platform interface. The sequence is a proposed model and has not been empirically tested in this article.

6. DEVELOPING PATTERN GENERALIZATION

Pattern tasks can provide an accessible entry into algebraic generalization. Pupils may study a sequence of figures containing 3, 5, 7, and 9 objects and describe how each figure changes. They should be encouraged to articulate the rule in words before introducing formal notation.

A teacher-prepared GeoGebra model can dynamically display successive figures. LearningApps can ask pupils to order pattern stages and match descriptions with images. Wordwall can offer contrasting examples that follow or violate a proposed rule.

Kahoot can be used to present multiple candidate rules and ask pupils to justify which rule is consistent with the displayed cases. Importantly, several rules may fit a limited sequence; teachers should avoid implying that a small number of terms always determines a unique mathematical rule.

The instructional aim is to shift pupils from “what comes next?” to “what changes, what stays the same, and how can I explain the relationship?”

7. FORMATIVE ASSESSMENT AND FEEDBACK

Interactive platforms provide immediate response data, but the quality of assessment depends on task design. Multiple-choice questions can efficiently reveal common errors, yet may not capture the reasoning behind a correct selection.

An assessment framework should include interpretation of equality, recognition of patterns, use of mathematical language, translation among representations, and justification of a solution. Teachers can combine platform responses with oral explanations, written work, and short reflective prompts.

When a substantial proportion of pupils selects an incorrect option, the teacher should investigate the misconception rather than simply repeat the question. Feedback can include contrasting examples, peer explanation, and a return to concrete models.

Competitive scores should not be used as the sole measure of mathematical ability. Reading speed, device familiarity, and response time may influence game outcomes independently of conceptual understanding.

8. IMPLEMENTATION CONDITIONS AND INCLUSION

Effective integration requires reliable equipment, suitable classroom organization, teacher preparation, and appropriate language support. A single shared screen can be sufficient for collective reasoning, while small-group rotations may provide an alternative when devices are limited.

Teachers should review every digital task for mathematical accuracy, age suitability, accessibility, and clarity. Interfaces should avoid excessive decoration, unnecessary sound, and instructions that are difficult for younger learners to read.

Privacy and safeguarding also matter. Schools should review platform terms, age restrictions, account requirements, and student-data practices before using named applications with children. Where possible, activities should minimize collection of personally identifiable information.

Offline worksheets, manipulatives, and discussion should remain available so that participation is not dependent on personal device ownership or connectivity.

9. LIMITATIONS AND RESEARCH AGENDA

The present article is a conceptual narrative review, not a systematic evidence synthesis. It does not establish causal effects of GeoGebra, Wordwall, LearningApps, or Kahoot on learning outcomes, and the platforms' features may change over time.

Future studies should compare different instructional designs rather than merely compare "technology" with "no technology." For example, researchers could examine dynamic visualization with and without explanatory prompts, or game-based quizzes with and without follow-up mathematical discussion.

Outcome measures should include conceptual understanding, transfer, delayed retention, learner engagement, and equitable participation. Teacher interviews and classroom observations could help explain why an intervention succeeds or fails in a particular context.

Comparative studies should control for differences in teaching time, prior knowledge, and the complexity of mathematical tasks. These safeguards are essential for interpreting observed learning differences responsibly.

10. CONCLUSION

GeoGebra, Wordwall, LearningApps, and Kahoot can serve complementary functions in primary-school algebra instruction. Dynamic visualization, representation matching, structured practice, and formative questioning may help learners explore equality, unknown quantities, and patterns when the activities are pedagogically coherent.

The central principle is that interaction with a digital tool should lead to interaction with a mathematical idea. Teachers must guide explanation, reflection, verification, and transfer. Further empirical research is needed to establish the conditions under which these applications contribute to sustained algebraic understanding.

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