A TAM Evaluation of NodeBook™ Adoption in Algebra Teaching: An Exploratory Analysis

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***Abstract*— Instructors in STEM education have begun adopting interactive, non-linear tools for pedagogical advantage. However, technological barriers continue to hinder their adoption. Based on the Technology Acceptance Model (TAM), this pilot study investigates the behavioral intentions of 30 algebra teachers as they evaluate NodeBook, a visual courseware platform. A multiple linear regression model revealed that computer self-efficacy ($\beta = 0.502$, $p = 0.011$) is the most important factor driving adoption intention. The direct regression coefficients of perceived ease of use and perceived usefulness were not statistically significant in this sample, although perceived ease of use was strongly correlated with adoption intention. This study suggests that building teachers' confidence in using the platform is crucial for successfully integrating visual courseware into STEM education, especially algebra.**

Keywords—Technology Acceptance Model; Visual Knowledge Mapping; NodeBook; STEM Education; Algebra Pedagogy.

I. Introduction

Mathematics education, especially algebra, is fundamental to most secondary and tertiary STEM curricula [1]. However, the transition from the concrete concepts of arithmetic to the abstract concepts of algebra is often very difficult for most students [2]. Traditional instructional materials such as textbooks and PowerPoint slides follow a linear pattern in presenting the learning content and face limitations in representing interconnected, non-linear mathematical principles [3]. Modern interactive visual knowledge mapping tools and courseware are intended to overcome these limitations [4].

NodeBook[1] is a presentation technology and a learning platform that transform linear educational content into connected, non-linear knowledge trees. It is built upon a patented spatial user interface with multiple layers that helps authors and instructors create, connect and navigate interactive nodes representing concepts in a clutter-free design [5]. It displays the structural links between fundamental and advanced concepts and aims to support streamlined classroom delivery by reducing cognitive load and improving conceptual clarity [6].

Previous research has demonstrated that NodeBook is associated with higher student motivation in mathematics learning [7]. Furthermore, instructor adoption determines the success of any technical improvement in a digital instructional tool [8]. Thus, it is important to explore the factors that influence instructor adoption as well. If teachers perceive a tool as complex, rigid, or time-consuming, operational resistance will limit its adoption [9].

The present study explores the behavioral intentions of a sample of algebra teachers (n=30) and employs Technology Acceptance Model (TAM) [10]. This study examines Computer Self-Efficacy (CSE) [11], Perceived Usefulness (PU), and Perceived Ease of Use (PEOU) as the factors that could affect technology acceptance among mathematics educators.

The paper is organized as follows: Section II presents the review of literature on TAM and nonlinear courseware; the sample details and research design is outlined in Section III; Section IV describes the statistical results in various forms; discussion along with practical implications are included in Section V; and Section VI concludes with suggestions for future research.

II. Literature Review

A. TAM in STEM Education

The Technology Acceptance Model proposed by Davis in [10] suggests that the adoption of new technology is determined mainly by two variables: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). TAM proved to be useful in explaining the differences in the adoption of different technologies the education sector tries to integrate, like learning management systems, e-learning platforms, and STEM applications [12], [13]. The TAM framework is extended to include user-dependent characteristics such as Computer Self-Efficacy (CSE) [11] as an external factor that affects user perceptions either directly or indirectly [14].

Research on the factors affecting software adoption in STEM pedagogy suggests mixed results. Studies that focus on general enterprise software identify PU as the primary factor determining long-term usage [15]. However educational research indicates that low operational complexity, pointing to PEOU, strongly shapes technology adoption [16]. Digital tools that require minimal training are more likely to be incorporated into daily instruction [17].

[1] Available at: https://www.nodebook.ae

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B. Visual Knowledge Mapping and Nonlinear Courseware

In visual knowledge mapping, complex domain knowledge and information are represented in the form of a network of interconnected topics to help learners understand them with less effort [4], [6]. The use of non-linear courseware in courses of mathematics enables educators to display concepts more effectively, demonstrating the relationship between foundational algebraic operations and higher-order thinking problems [3].

Although theoretical agreement increasingly supports visual learning, there is still limited empirical research measuring instructors' acceptance of visual courseware. A large proportion of recent research studies emphasize student-side learning outcomes instead of the adoption barriers encountered by instructors [18]. The current study addresses this gap by proposing an empirical TAM evaluation of NodeBook, demonstrating how educators' intent in algebra education is influenced by technical self-efficacy and interface usability.

III. Methodology

A. Target Population and Sample Details

The study targeted algebra teachers across primary and secondary schools in the United Arab Emirates. Teachers were invited through school network and they participated voluntarily. A sample of 30 algebra teachers were in the pilot study, 21 of which were female teachers (70.0%) and 9 were male teachers (30.0%). They had varying teaching experience from "less than 5 years of experience" (23.3%) to "more than 20 years of experience" (30.0%). Furthermore, 20.0% of the teachers had between 6 and 10 years of experience, and 26.7% of them had between 11 and 20 years of experience. Teachers were introduced to NodeBook and given the chance to interact with it directly and freely to explore the algebra content of their choice before given the questionnaire to complete.

B. Research Design and TAM Framework

A quantitative research design based on TAM was employed to explore teachers' behavioral intentions in adopting NodeBook, a visual presentation technology used for non-linear mapping of a course on algebra. This exploratory study was conducted to evaluate how technical self-efficacy and user interface perceptions influence adoption intent.

The structural model evaluated the following constructs: (i) Computer Self-Efficacy (CSE): which measures confidence and perceived proficiency in using NodeBook (3 items); (ii) Perceived Usefulness (PU): which assesses the extent to which a teacher believes that NodeBook will improve job performance, productivity, and instructional effectiveness (8 items); (iii) Perceived Ease of Use (PEOU): which is an indication of the degree of ease in navigating and controlling NodeBook effortlessly (6 items); and (iv) User's Intention (UI): which is the dependent variable measuring teachers' intent, degree of satisfaction, and willingness to include NodeBook in their daily classroom instruction (4 items).

C. Instrumentation and Measurement Scale

The survey used a questionnaire that included 28 items, adapted from validated TAM [10], computer self-efficacy [11], and e-learning acceptance scales [14]. The items followed a standard Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Only 21 items were analyzed as they were within the TAM framework used here.

- **Computer Self-Efficacy** ("CSE"): included items assessing proficiency expectations, operational confidence, and familiarity with digital resources.
- **Perceived Usefulness** ("PU"): included items evaluating task speed, productivity, job performance, instructional effectiveness, and learning efficiency.
- **Perceived Ease of Use** ("PEOU"): included items measuring the rapidity of learning, adaptability of the system, interface transparency, degree of controllability, and general simplicity of operation.
- **User's Intention** ("UI"): included items evaluating tool satisfaction, intent to adopt NodeBook in algebra classes, and long-term usage commitment.

D. Data Analysis Procedures

Data were analyzed in IBM SPSS Statistics 26.0. We computed item-level and composite descriptive statistics, assessed internal consistency with Cronbach's α and factorability with the KMO index and Bartlett's test. We also examined the associations of CSE, PU, and PEOU with UI using Pearson's r, and estimated an OLS multiple regression of UI on the three predictors.

IV. Results

A. Construct Reliability and Validity Analysis

Table I reports Cronbach's α, the KMO index, and Bartlett's test for each construct.

TABLE I. RELIABILITY AND SAMPLING ADEQUACY ANALYSIS

Construct	Items	α	KMO	χ^2	df
CSE	3	.630	.618	10.498	3
PU	8	.901	.812	152.389	28
PEOU	6	.860	.800	82.128	15
UI	4	.673	.553	27.510	6

* $p < .001$ for all constructs except CSE ($p = .015$)

The details presented in Table I indicate that Perceived Usefulness ($\alpha = 0.901$, KMO = 0.812) and Perceived Ease of Use ($\alpha = 0.860$, KMO = 0.800) show the highest internal consistency and sampling adequacy. Computer Self-Efficacy ($\alpha = 0.630$, KMO = 0.618) and User's Intention ($\alpha = 0.673$, KMO = 0.553) are only marginal for exploratory scale validation, so results involving these two constructs should be interpreted with caution. Across the constructs, Bartlett's test of sphericity was statistically significant ($p < 0.05$), confirming the factorability of the correlation matrix.

B. Correlation Analysis

To assess the correlation between the independent variables CSE, PU and PEOU, and the dependent variable UI, Pearson correlation coefficients were computed. The results are presented in Table II.

TABLE II. PEARSON CORRELATION MATRIX ($N = 30$)

Construct	1	2	3	4
1. CSE	1.000			
2. PU	.356	1.000		
3. PEOU	.634**	.605**	1.000	
4. UI	.659**	.351	.567**	1.000

* $p < .05$, ** $p < .01$ (2-tailed).

CSE shows the strongest positive correlation with UI ($r = 0.659$, $p < 0.001$), followed by PEOU ($r = 0.567$, $p = 0.001$), and CSE and PEOU are strongly correlated with each other ($r = 0.634$, $p < 0.001$). Perceived Usefulness (PU) shows a moderate correlation with UI ($r = 0.351$, $p = 0.058$), which is not statistically significant.

C. Multiple Linear Regression Analysis

We also applied multiple linear regression analysis using the Ordinary Least Squares method to assess the predictive power of the TAM framework on the behavioral intention of teachers to adopt NodeBook for algebra instruction.

The results, presented in Table III, indicate that the regression model was statistically significant ($F(3,26) = 7.759$, $p < 0.001$). The independent variables explain 47% of the variation in teachers' intention to adopt NodeBook (adjusted $R^2 = 0.41$).

TABLE III. OLS REGRESSION COEFFICIENTS (DEPENDENT VARIABLE: USER'S INTENTION)

Predictor	*B*	*SE*	*β*	*t*	*p*
(Constant)	4.283	2.584	—	1.657	.109
CSE	.627	.230	.502	2.724	.011
PU	.016	.083	.034	.188	.852
PEOU	.128	.122	.228	1.056	.301

According to Table III, Computer Self-Efficacy (CSE) is the most important direct predictor of adoption intention ($\beta = 0.502$, $t = 2.724$, $p = 0.011$). The variables PEOU ($\beta = 0.228$, $p = 0.301$) and PU ($\beta = 0.034$, $p = 0.852$) were not statistically significant in this sample. Fig. 1 shows these results, where CSE has a strong positive effect ($\beta = 0.502$, $p = 0.011$), while PEOU and PU effects are smaller and not statistically significant. We observed no violations of the examined assumptions as indicated by regression diagnostics: variance inflation factors ranged from 1.58 to 2.31 (tolerance ≥ 0.43), residuals were approximately normal (Shapiro–Wilk $p = 0.496$), the Durbin–Watson statistic was 1.75, and no influential observations were detected (maximum Cook's distance = 0.49).

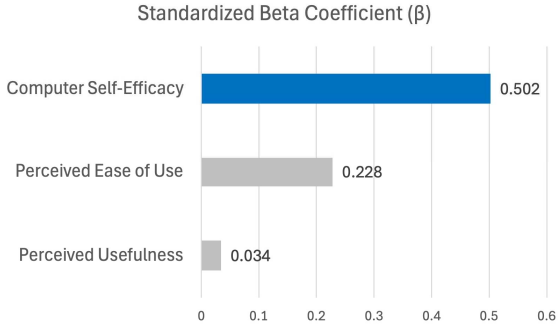

Fig. 1. Relative Impact of Predictors on Intention to adopt NodeBook.

V. Discussion

This study provides key insights into algebra teachers' evaluations when adopting non-linear courseware such as NodeBook.

A. The Dominance of Computer Self-Efficacy

The independent variable of Computer Self-Efficacy (CSE) appears as the foremost determinant of educators' intention to use NodeBook ($\beta = 0.502$, $p = 0.011$). Most of the traditional TAM scholarship positions Perceived Usefulness (PU) as the central predictor of software adoption within workplace setting, and this finding differs from the conventional literature. It is, however, consistent with evidence that teachers' technology-specific self-efficacy shapes their acceptance of educational technology [16]. Hence, this pilot study proposes that teachers' confidence in their ability to use a tool plays a central role in their intention to adopt it.

B. The Role of Ease of Use and Usefulness

From a statistical point of view, Perceived Ease of Use (PEOU) ($p = 0.301$) and Perceived Usefulness (PU) ($p = 0.852$) did not show significant direct effects on educators' adoption intention in this sample, which may partly reflect limited statistical power. Nonetheless, PEOU is strongly correlated with both UI ($r = 0.567$) and CSE ($r = 0.634$). It is worth noting that PU and PEOU likewise demonstrate a strong correlation ($r = 0.605$) in a comparable manner. Therefore, ease of use should not be dismissed, as teachers who feel confident using NodeBook also tend to find it easy to use.

C. Practical Implication for Instructional Software Design

A compelling message is delivered through this study to those who design and deploy instructional software: teachers' confidence must be built. Greater uptake may stem from hands-on training, guided onboarding, and in-product support that help teachers feel capable of using the platform, alongside simplified navigation and coherent linkages among topics in STEM courses such as algebra.

D. Limitations of the Study

The small sample ($n = 30$) limits statistical power, so the non-significant coefficients of PEOU and PU may reflect insufficient power rather than the absence of an effect. Additionally, the use of a convenience sample from UAE schools evaluating a single platform limits the generalizability of the findings to other contexts.

VI. Conclusion and Future Work

The present pilot study, based on the Technology Acceptance Model (TAM), explored the adoption intentions of algebra instructors towards NodeBook, a non-linear courseware designed to connect abstract concepts in mathematics. Computer Self-Efficacy (CSE) was identified to be the most important determinant ($\beta = 0.502$, $p = 0.011$) in instructors' intention to use NodeBook in their teaching, which implies that teachers' confidence matters most for adoption intention in this pilot study. The observed CSE-PEOU and PU-PEOU correlations suggest a possible indirect role to be studied in the future.

In the future, we plan to increase the sample size and include a wider range of geographic locations. We also aim to connect findings about students' responses to learning through non-linear courseware with instructors' adoption behavior.

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H. M. Deif is the founder of NodeBook™ and the inventor of its patented technology [5]. NodeBook is currently free of charge and generates no revenue. The other authors declare no competing interests.

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