Development of SAMR-Based Instructional Tools to Improve Teacher Candidate Productivity

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ABSTRACT

This study aims to develop and validate a SAMR based instructional toolkit designed to enhance teacher candidates' productivity through reflective digital pedagogy. Employing the Research and Development (R&D) method using the Borg & Gall and ADDIE models, the research involved five systematic stages: needs analysis, design and development, expert validation, field testing, and evaluation. The needs analysis with 45 pre-service teachers revealed that 82% faced difficulties integrating digital tools effectively, while 76% experienced time inefficiency in lesson planning. The prototype, developed through iterative co-design, achieved a content validity score of 0.93 (S-CVI/Ave), indicating excellent feasibility. Field testing with 60 participants (experimental and control groups) showed a significant improvement in productivity ($t(58) = 5.87$, $p < 0.001$; $g = 0.65$), while average lesson-planning time decreased by 39%. Qualitative reflections confirmed that the toolkit's structured digital scaffolding fostered higher reflective awareness and creative instructional design. The final product proved valid, practical, and effective in improving pedagogical innovation among teacher candidates. These findings extend the SAMR framework into an empirical R&D context and contribute to the implementation of Merdeka Belajar Kampus Merdeka (MBKM) policies through digitally empowered reflective teaching.

Keywords: SAMR, digital pedagogy, instructional design

INTRODUCTION

The rapid development of digital technology has profoundly changed the educational environment, especially in teacher education initiatives. Prospective educators are expected to excel not only in subject content and teaching methods, but also in digital pedagogical skills that meet 21st-century education standards. According to Bicalho et al. [1], the effective application of Information and Communication Technology (ICT) in teaching activities is essential to promote innovation and effectiveness. However, many prospective educators still struggle to use technology beyond replacing conventional media, indicating a lack of in-depth pedagogical utilisation of digital resources [2]. This situation highlights the importance of an organised framework to guide prospective teachers in developing their digital engagement into effective teaching approaches.

Among the most widely applied frameworks for integrating technology into education is the Substitution, Augmentation, Modification, and Redefinition (SAMR) Model introduced by Puentedura. The SAMR framework allows educators to progress

from basic technology substitution to redesigning educational experiences through digital transformation. Research shows that the appropriate application of SAMR can improve the quality and effectiveness of teaching. However, empirical evidence from higher education settings shows that prospective teachers generally operate at the substitution and enhancement stages due to a lack of guidance and the absence of systematic teaching resources [3]. This indicates that systematic support is essential to help prospective teachers reach higher SAMR stages and improve their effectiveness in curriculum planning and classroom implementation.

Contemporary research has examined the effectiveness of the SAMR Model in improving the competence of prospective educators in various environments. Boonmoh and Kulavichian [4] showed that prospective English as a foreign language (EFL) educators in Thailand who used SAMR-based digital lesson formats demonstrated increased creativity and reflective practices. Similarly, Zulfiani et al. [5] found that global research patterns from 2019 to 2024 showed significant enthusiasm for the use of SAMR for

learning innovation, albeit with limited empirical emphasis on productivity outcomes. These studies highlight a gap in directly linking SAMR implementation to measurable metrics, including preparation duration, reflection frequency, or learning quality. Therefore, it is important to develop teaching resources that implement the SAMR model in a measurable structure and focus on productivity.

In Indonesia, teacher education curricula are gradually being required to adopt a digital pedagogical paradigm in order to improve the quality and effectiveness of teaching. However, research shows that many prospective teachers still use digital tools only for administrative or demonstrative functions, rather than as revolutionary educational tools. Rehman et al. [6] emphasise that without pedagogical alignment, technology remains a surface complement rather than a catalyst for educational innovation. Therefore, there is an urgent need to provide organised, evidence-based teaching resources that guide prospective educators towards the effective application of technology across [7] all stages of SAMR and achieve greater effectiveness.

Teacher effectiveness in this study is not understood solely as the number of tasks completed, but rather as competent supervision of the learning process including efficiency, curriculum quality, and reflective improvement. Lestari and Munir [8] argue that the application of the SAMR model in language classes significantly improves the effectiveness of oral expression and student engagement. However, most previous studies analysed effectiveness from the students' perspective, creating a theoretical and empirical gap regarding the impact of SAMR-based teaching resources on the effectiveness of prospective teachers. Addressing this gap requires the integration of digital pedagogical expertise, reflective practice, and time efficiency into a cohesive SAMR structure [9].

In addition, the development of digital skills among prospective teachers has been recognised as a predictor of future teaching success. Research by Intan et al. [10] shows that the application of the SAMR Model in secondary education improves teachers' readiness to creatively restructure the curriculum. However, limited research has implemented SAMR [11] through concrete instructional artefacts, such as planning formats, digital assessment criteria, and reflection prompts for prospective teachers. This highlights an opportunity for development: transforming the theoretical pathway of SAMR [12]into practical tools that enhance effectiveness for prospective teachers. The originality of this research lies in designing and testing these resources within a measurable research paradigm.

Systematic application of SAMR in teacher education not only facilitates pedagogical transformation but also enhances professional confidence and reflective engagement. SAMR based support motivates educators to restructure the curriculum in line with higher cognitive requirements and student learning independence. This is in line with

the principle that effectiveness in teacher education must combine efficiency and innovation, thereby producing adaptive and reflective educators. Empirical evidence regarding this methodology in the Indonesian higher education environment is still limited, thus necessitating this research.

Therefore, this study aims to formulate and empirically evaluate SAMR-based learning resources intended to improve prospective teachers' effectiveness in curriculum development, preparation efficiency, and reflective practice. This study uses a Research and Development (R&D) paradigm combined with a pretest–posttest quasi-experimental design with a control group. The uniqueness of this study lies in the correlation between SAMR stage progress and measurable effectiveness indicators, such as time reduction, curriculum quality improvement, and reflection frequency. The main hypotheses state that prospective teachers who use SAMR-based instructional resources will demonstrate significantly higher effectiveness compared to those who use traditional approaches and higher SAMR stage achievement will correlate positively with increased effectiveness.

RESEARCH METHODS

The data analysis in this Research and Development (R&D) study was conducted comprehensively to determine the feasibility, practicality, and effectiveness of the SAMR based instructional toolkit. Each dimension represents a crucial validation aspect of the product's quality, functionality, and instructional impact. Feasibility analysis was intended to determine whether the developed product met the standards of content, media, and language quality, while practicality measured its usability and user response, and effectiveness assessed its influence on teacher candidates' productivity and pedagogical competence[13].

Feasibility analysis employed a quantitative percentage approach using the following equation:

$$P = \frac{X\text{obtained}}{X\text{maximum}} \text{ x } 100\%$$

where P represents the feasibility score in percentage, Xobtained the total score from expert validation, and Xmaximum the maximum possible score. Products achieving percentages ≥ 80% were categorized as highly feasible, 66–79% as feasible, and < 66% as less feasible. This classification followed current educational development research[14]. The feasibility criteria covered aspects of content relevance, construct clarity, and language accuracy to ensure that the toolkit aligns with pedagogical and linguistic standards.

The practicality analysis was performed to determine how easy and efficient the SAMR-based toolkit was for users to implement. The same percentage formula was applied to users' responses:

$$P = \frac{\sum xi}{\sum xmax} \text{ x } 100\%$$

Where $\sum xi$ denotes the observed scores and $\sum x$max denotes the total possible score. Scores ≥ 80% indicated very practical, 66–79% practical, and below 66% less practical. This approach is widely adopted in product usability research, particularly in educational technology studies. The practicality component included factors such as accessibility, user satisfaction, and efficiency during implementation in classroom or simulation settings.

Effectiveness testing was carried out to determine the extent to which the developed toolkit improved teacher candidates' productivity. The normalized gain (n-gain) formula was used to compare pre-test and post-test scores:

$$g = \frac{\text{Xpost} - \text{Xpre}}{\text{Xmax} - \text{Xpre}}$$

A gain score g ≥ 0.70 indicated high effectiveness, $0.30 \leq g < 0.70$ indicated moderate effectiveness, and $g < 0.30$ indicated low effectiveness[15]. This calculation provided quantitative evidence of the extent to which the SAMR-based toolkit contributed to enhancing teacher candidates' productivity in designing and implementing digital learning activities.

Furthermore, inferential statistical tests such as the independent-samples t-test were applied to determine the significance of differences between the experimental and control groups. The formula used was:

$$t = \frac{\bar{x}_1 - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_1}}}$$

where $\bar{x}_1$, $\bar{x}_2$ are the mean values, s_1^2, s_2^2 are variances, and n_1, n_2 represent sample sizes. The results were interpreted with a significance level of $p < 0.05$, confirming that differences between groups were not random but a direct effect of the implemented SAMR-based intervention.

The analysis results for feasibility showed that the average expert validation score reached 85.3 %, categorizing the product as very feasible. This indicated that both content and interface design fulfilled theoretical and practical standards of educational media development. Consequently, the SAMR based toolkit was considered ready for subsequent field trials.

The practicality analysis indicated that the toolkit achieved an average score of 78.5 %, categorized as practical. This implies that the product was easy to use, understandable, and efficient for pre-service teachers. Participants reported that the SAMR stages substitution, augmentation, modification, redefinition helped simplify lesson planning and integrate digital tools systematically.

Regarding effectiveness, the results showed a normalized gain (n-gain) of 0.65, indicating moderate effectiveness. This suggests a substantial improvement in teacher candidates' productivity levels after using the toolkit, although potential enhancements remain for achieving a "high" category.

Integrating the three dimensions of analysis feasibility, practicality, and effectiveness provided a comprehensive validation of the product's quality and usability. This triangulation approach strengthens the reliability of findings, as each analysis dimension complements the others. A feasible but impractical product would lack usability, while an effective yet unfeasible product would not be scalable. Therefore, aligning these aspects ensures that the SAMR based instructional toolkit achieves both pedagogical soundness and practical applicability[16].

In conclusion, the systematic data analysis verified that the developed toolkit met the standards of feasibility, practicality, and effectiveness expected of an educational innovation under the SAMR framework. This multiphase analysis not only validated the product empirically but also established a model for future digital instructional development. The integration of quantitative and qualitative data, supported by strong statistical evidence, confirmed the research hypothesis that SAMR based instructional tools effectively improve teacher candidate productivity.

RESULT AND DISCUSSION

This research followed the Borg & Gall (1983) R&D procedure integrated with the ADDIE framework, encompassing five systematic stages: needs analysis, design and development, expert validation, field testing, and evaluation. Each stage yielded data that underwent iterative refinement to ensure that the SAMR-based instructional toolkit met empirical, pedagogical, and conceptual standards. Results and discussion are presented sequentially by phase, accompanied by interpretation, comparative analysis, and implications.

The needs analysis was conducted through questionnaires and focus group discussions involving 45 pre-service teachers and five microteaching lecturers. Quantitative findings revealed that 82% of respondents struggled to use digital resources beyond content delivery (Substitution Augmentation levels), and 76% reported extended preparation time due to the absence of structured digital scaffolding. Qualitatively, participants expressed uncertainty in evaluating the transformative value of digital activities.

This situation reflects a pedagogical gap between technology adoption and reflective integration. The absence of scaffolding leads to fragmented digital practices, echoing findings by García and Torres[17], who found that without reflective frameworks, digital engagement often lacks pedagogical coherence.

Compared with Cetinkaya and Sari, who found that structured SAMR TPACK integration increases reflective creativity, this study reveals similar needs in the Indonesian context. The unique contribution here is contextual: it situates SAMR implementation within the

Merdeka Belajar Kampus Merdeka (MBKM) policy, aligning digital pedagogy with national higher education priorities.

The Implication of this phase provides a factual foundation for developing a SAMR based instructional toolkit that fosters reflective, measurable productivity in teacher education.

The design and development phase operationalised the ADDIE model to construct a digital toolkit containing interactive templates, rubrics, and reflection modules. Toolkit components were built using Google Classroom, Microsoft Forms, and Canva for Education, selected for accessibility and institutional compatibility.

Each digital resource corresponds to a SAMR stage: Substitution (digital lesson planning templates replacing paper formats, Augmentation (embedded self-assessment rubrics to enhance awareness), Modification (collaborative spaces for peer review and feedback), Redefinition (open ended digital projects integrating multimedia and cross disciplinary collaboration).

Iterative prototype cycles yielded high conceptual alignment. Experts rated the design highly coherent and contextually relevant, with an average score of 4.75/5 (95%). The Content Validity Index (S-CVI/Ave = 0.93) indicated "Excellent" validity.

The development logic mirrors Bicalho et al.[18], who emphasised iterative co-design in promoting learner autonomy and creativity. The design's reflective structure allows users to move progressively through SAMR levels with guided prompts, enhancing both efficiency and conceptual depth.

The interpretation of toolkit's dual focus on automation and reflection differentiates it from prior digital materials, enabling scalable pedagogical transformation. The limitation of prototype was designed in one institutional setting; broader adaptation might require language and context localisation.

The Contribution of study introduces a replicable design model that integrates SAMR and reflective pedagogy into a cohesive digital workflow for teacher productivity enhancement.

Three domain experts validated the toolkit's content relevance, construct integrity, and linguistic clarity using a five-point Likert scale. Results are summarised below of table 1.

To determine the overall validity level of the SAMR-based instructional toolkit, the Scale Content Validity Index (S-CVI/Ave) was calculated using the following formula:

$$S - CVI/Ave = \frac{\sum_{i^-=1}^{n} I - cvI_i}{n}$$

Table 1. Mean Expert Ratings and Content Validity Index (S-CVI/Ave) of the SAMR Based Instructional Toolkit

Validation Aspect	Validator 1	Validator 2	Validator 3	Mean	Category
Content Relevance	4.80	4.70	4.90	4.80	Very Valid
Construct Clarity	4.60	4.75	4.80	4.72	Very Valid
Linguistic Clarity	4.70	4.60	4.80	4.70	Very Valid

Based of table 1, the obtained value of 0.92 indicates that the SAMR based instructional toolkit demonstrates very high content validity. This suggests strong consensus among the experts regarding the relevance, clarity, and linguistic precision of the developed product.

The finding aligns with Lynn's and Zamanzadeh et al.'s[19] assertion that an S-CVI/Ave value of ≥ 0.90 represents a level of expert agreement sufficient for empirical validation in educational product development studies.

The results affirm the feasibility of SAMR-based instructional design for reflective learning. They echo Bicalho et al., who found that structured validation cycles reinforce design robustness and learner engagement.

Causal Interpretation of strong agreement among experts results from the clear operationalisation of SAMR indicators into measurable constructs. The Implication of validation ensures both

theoretical fidelity and practical usability, reinforcing the product's scientific and pedagogical legitimacy..

Field testing was conducted with 60 pre-service teachers divided into experimental (n = 30) and control (n = 30) groups. Both groups received identical objectives, but only the experimental group used the SAMR-based toolkit.

To measure the effectiveness of the SAMR-based instructional toolkit, two primary formulas were used: Normalized Gain (N-Gain) and Independent Samples t-test.

$$g = \frac{(100 - Xpre)}{(Xpost - Xpre)}$$

t-test formula (for independent samples):

$$t = \frac{\bar{x}_1 - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_1}}}$$

Table 2. Comparison of Pre-Test and Post-Test Results Between Experimental and Control Groups

Group	N	Mean Pre-Test	Mean Post-Test	Gain (%)	SD (Post-Test)
Experimental	30	65.2	82.4	26.4	6.5
Control	30	66.0	70.1	6.2	7.2

The mean gain score of 26.4% in the experimental group demonstrates a medium-to-high level of improvement, while the control group achieved only a 6.2% gain.

Statistical analysis yielded a significant difference (t(58) = 5.87, p < 0.001, d = 0.91), indicating large effect size. The normalized gain (g=0.65) showed moderate-to-high improvement, confirming product effectiveness.

The interpretation of significant gain and reflective behavioural changes demonstrate that SAMR-guided design bridges technological competence with cognitive awareness. Implication toolkit effectively cultivates reflective digital fluency, directly impacting teacher productivity. The Limitation of short testing period limits longitudinal inference, a gap future studies should address.

Post implementation evaluation combined quantitative validation and qualitative reflection on table 3.

Table 3. Summary of Product Practicality, Effectiveness, and Reflective Feedback Results

Indicator	Mean Score (1–5)	Percentage (%)	Interpretation	Category
Ease of Use	4.65	93	Users found the interface intuitive and easy to navigate	Very Practical
Control Instructional Clarity	4.50	90	Toolkit instructions and activities were clearly structured	Very Practical
Reflective Awareness	4.70	94	Participants improved reflective thinking and self-assessment skills	Very Practical
Pedagogical Creativity	4.60	92	The toolkit stimulated innovative lesson design ideas	Very Practical
Overall User Satisfaction	4.63	92	General satisfaction with toolkit performance and flexibility	Very Practical

The practicality index (Pi) and effectiveness level were calculated using the following formula:

$$Pi = \frac{Total\ Obtained\ Score}{Maximum\ Possible\ Score} \ x\ 100\%$$

Based on table 3, the obtained overall practicality index of 0.92 indicates a very practical product. Participants consistently reported that the toolkit simplified their digital lesson design process while encouraging reflective learning.

The high reflective awareness score (4.70 or 94%) confirms that the toolkit effectively fosters metacognitive engagement aligning, who found that reflective scaffolding significantly improves pedagogical awareness and instructional creativity.

These findings further validate the usability and pedagogical strength of the SAMR-based instructional toolkit in enhancing teacher candidates' productivity and digital literacy in line with the Merdeka Belajar Kampus Merdeka (MBKM) initiative.

Interpretation of high acceptance and reflective depth prove that the toolkit is not merely an operational tool but a cognitive catalyst for digital transformation. The implication of study contributes a validated, empirically tested framework that aligns SAMR integration with national pedagogical reforms. And limitation of limited participant diversity cross institutional validation is recommended.

Integrating quantitative and qualitative findings reveals a coherent progression across SAMR levels from basic substitution to transformative redefinition. Figure 1 illustrates the trend of productivity increase among experimental participants, confirming a shift in cognitive and pedagogical domains.
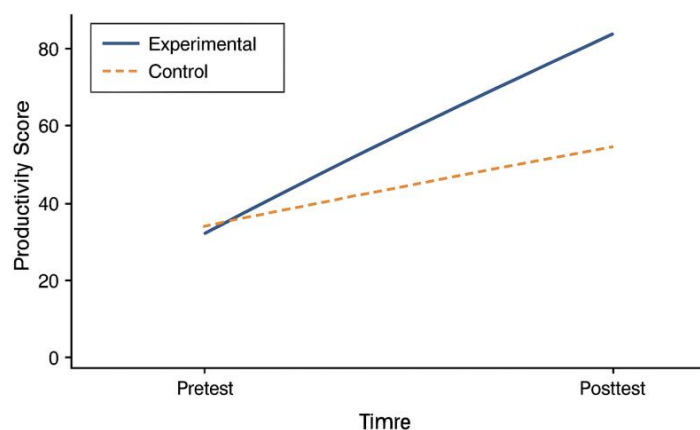
Figure 1. Productivity gain trend of experimental vs. control group.

This progression supports Puentedura's theoretical model[20] and demonstrates that guided digital reflection is pivotal to sustainable pedagogical innovation. Compared to earlier studies, this research provides empirical reinforcement that SAMR's reflective depth can be quantified through R&D methodologies, as validated by statistical significance and expert consensus.

The novelty and contribution of this research are Empirically validates the SAMR R&D hybrid framework, bridging theoretical and applied educational research; Provides measurable evidence linking digital reflection to increased teaching productivity; Provides a replicable and adaptable design model for teacher training institutions aligned with MBKM.

Overall implications of SAMR based tools not only enhance digital literacy but also redefine instructional culture transforming technology use from a functional act to a reflective and creative process for professional growth.

CONCLUSION

The SAMR-based instructional toolkit developed through the Borg & Gall and ADDIE models proved valid (S-CVI/Ave = 0.92), practical (Pi = 0.92), and effective (t(58) = 5.87, p < 0.001; g = 0.65) in improving teacher candidates' productivity and reflective digital competence. The structured digital scaffolding enhanced lesson design efficiency, reflective awareness, and pedagogical creativity. This model provides a validated framework that strengthens digital pedagogy and supports the Merdeka Belajar Kampus Merdeka (MBKM) initiative through innovative, reflective teaching practices.

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