Scale for Optimizing Assessment Activities with Digital Technology Integration toward Transformative Learning

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***Abstract*—Numerous studies have examined the development and validation of scales concerning technology use, integration, self-efficacy, and perceived barriers among teachers or students in utilizing technology. However, there has been limited focus on how teachers optimize assessment activities through the integration of digital technology for transformative learning. To bridge this research gap, this study aimed to develop and validate a scale that focuses on optimizing assessment activities with digital technology integration for transformative learning among senior high school teachers. Initially, a 40-item questionnaire was crafted and underwent face and content validations. Subsequently, a revised 48-item questionnaire was piloted among teachers in a specific region of the Philippines. The collected data underwent exploratory factor analysis using Varimax with Kaiser normalization rotation extraction, and Cronbach's alpha reliability testing. A 27-item scale comprising seven latent constructs was developed and validated. The seven constructs were as follows: creating video presentations, utilizing digital platforms, employing learning management systems, utilizing survey administration software, incorporating digital art, utilizing graphic design software, and integrating social media publishing. These factors provide insights into how teachers can optimize their assessment activities by leveraging these seven constructs with digital tools, ensuring students gain meaningful learning experiences.**

***Keywords*—assessment activities, digital technology, integration, transformative learning**

I. Introduction

In the aftermath of the global health crisis, educational systems worldwide confront unparalleled challenges that demand both the delivery of quality education and the prioritization of health, safety, and well-being for all stakeholders. This imperative resonates with the United Nations Sustainable Development Goal 4—Quality Education, which advocates for inclusive, equitable access to lifelong learning opportunities.

As digital technologies become pervasive in educational environments, it is necessary for educators to acquaint themselves with these tools and effectively integrate them into classroom activities, while remaining abreast of emerging developments [1]. Recent studies have begun to scrutinize the post-pandemic progression of technology integration in education [2], with the COVID-19 pandemic notably hastening and broadening the utilization of online teaching and learning technologies [3].

In the Philippines, initiatives such as the K to 12 curriculum and Sulong EduKalidad underscore a commitment to holistic development, emphasizing the mastery of content and performance through technology-integrated tasks geared toward transformative learning. Through technology integration, learners can perceive vivid applications of their learning to real-life scenarios, fostering deep and meaningful transformative learning. Transformative learning focuses on the idea that students can adapt their cognitive processes when exposed to new perspectives. This approach goes beyond the mere acquisition of knowledge, cultivating autonomous thinking and significant engagement with learning. Transformative learning plays a crucial role in educational development and has wide-ranging practical applications [4]. Flexible learning modalities, including online, offline, and blended approaches, have been embraced to cater to diverse learner needs amid varying levels of internet access [5].

Against this backdrop, the integration of technology into teaching practices has become indispensable, especially in contexts like the Philippines, where diverse learning modalities, particularly online and remote learning, have gained prominence. This integration, propelled by necessity during the pandemic, presents both challenges and opportunities in educational delivery [6]. Despite initial obstacles such as unreliable internet access and technical glitches, educators have increasingly turned to digital tools to bolster learning, with students exhibiting enthusiasm for their utilization [7, 8].

Various countries demonstrate distinct approaches to technology integration in education, with outcomes ranging from enhanced learning outcomes to exacerbated inequalities [9, 10]. Nevertheless, the recurring theme across contexts underscores the necessity for teachers to integrate technology into their pedagogical practices [11, 12].

In the Philippines, there is a clear emphasis on technology integration in classrooms, but there has been limited research into its various aspects [5, 13]. Frameworks such as Substitution, Augmentation, Modification, and Redefinition (SAMR) provide guidance for effective technology integration, particularly in assessment activities, which serve as evidence for transformative learning goals [14, 15]. However, only the last two stages of this model focus on transformative learning, and there are no specific indicators for each stage to help teachers determine whether their practices will lead to genuine transformation.

Despite the growing reliance on digital tools in teaching and learning, there remains a significant gap in the availability of instruments specifically designed to optimize assessment activities through technology integration for transformative learning. Existing scales address various aspects of technology, such as the development of an integrated scale of technology use in physics [16], a technology integration scale for teachers [17], a self-efficacy scale for technology usage in education [18], a comprehensive scale to measure perceived

barriers to technology integration [19], and a scale for technology integration in physics classes for junior high school science teachers [20]. However, there is a distinct lack of tools aimed at assisting teachers in optimizing assessment activities. This underscores the need for targeted research in this area.

To address this gap, this study aimed to develop and validate a scale for optimizing assessment activities with digital technology integration toward transformative learning, which aims to empower teachers to reimagine assessment practices and foster transformative learning experiences. Specifically, this study seeks to identify the factors that influence how teachers optimize assessment activities and examine the internal reliability of the developed scale.

Educational technology is expected to play an increasingly prominent role in teaching, testing, and assessment [3]. This study contributes to this trajectory by introducing a scale designed to optimize assessment practices in the digital age, thereby advancing the discourse on technology integration in education and its impact on transformative learning.

II. Literature Review

A. COVID-19, Post-COVID-19, and Technology Integration

Throughout the pandemic, educators have increasingly utilized technology to enrich students' language proficiency in the classroom, employing diverse approaches [8, 21, 22]. There has been a noticeable shift in educators' attitudes toward incorporating technology into their teaching methods compared to pre-COVID practices [23]. Moreover, students have shown considerable enthusiasm for integrating digital tools into both in-class and extracurricular experiences [7, 8].

While acknowledging the limited use of technology in classrooms before the pandemic, educators found themselves embracing various technological tools during the crisis [8]. Teachers have recognized the importance of integrating Information and Communication Technology (ICT) into their teaching practices in response to challenges posed by the COVID-19 pandemic [8, 24]. This includes implementing tasks that require higher-order thinking skills, particularly in digital contexts [8]. Additionally, it is evident that today's learners engage with education differently than previous generations [23], necessitating innovative and engaging language instruction methods [8, 25].

Research suggests that students learn best when knowledge is presented in authentic contexts, which can include interaction with tools, artifacts, or other individuals. This presents teachers with a valuable opportunity to explore situated learning through mobile technology [26].

B. Transformative Learning

Transformative learning emphasizes the idea that students can adapt their cognitive processes when exposed to new insights [27]. Through this transformative process, students are expected to reshape their beliefs, assumptions, and experiences into new, meaningful viewpoints. Central to transformative learning is critical reflection, which promotes independent thinking and personal freedom [27]. Transformative learning serves as the essence of education by fostering autonomous thinking and empowering students to critically evaluate ideas rather than passively accept them [28]. This process proves instrumental in educational development and has broad practical applications.

C. Digital Technologies

Digital technologies encompass electronic tools, systems, devices, and resources utilized for generating, storing, or processing data. Examples include social media, online games, multimedia, and mobile phones [29]. They provide opportunities conducive to blended, online, and mobile learning. However, there remains a limited understanding of their ease-of-use and acceptance, particularly within resource-constrained institutions of learning [30]. The integration of digital technologies has been heralded as a catalyst for enhancing and reforming curricula, teaching practices, learning processes, and achievement standards [31].

In the realm of higher education, digital technologies are regarded as transformative instruments for both teaching and learning purposes [30]. This is substantiated by the adoption of various technologies including online resources, learning management systems, diverse programs and applications, alongside devices such as laptops, tablets, and mobile phones to bolster educational initiatives [18].

D. SAMR Model and Technology Integration

The SAMR model serves as a guiding framework for teachers seeking to enhance technology integration in their teaching methods. While praised for its effectiveness in aiding the design and implementation of technology-driven learning activities, it has also faced criticism for perceived shortcomings in academic rigor and its emphasis on outcomes rather than processes [21]. Nonetheless, it remains a valuable tool for evaluating students' use of technology in achieving course or activity objectives [25].

The SAMR model delineates four stages. The first stage is Substitution, where technology merely replaces traditional methods without substantially altering the task [15]. For example, providing online lecture notes instead of photocopies represents a substitutional change. The second stage is Augmentation, where technology replaces traditional methods with a slight enhancement [15]. An example comes from a study where text messages were employed to enhance the retention of medical information among nursing students [25, 30].

The third stage of the SAMR model is Modification, which necessitates significant changes to the educational task [15]. An example of this stage is the adaptation of a flood disaster simulator for a course on applied geomorphology, in which simulated questions were sent as text messages, providing personalized learning experiences via mobile devices [30]. Redefinition, the highest level of the SAMR model, involves the creation of new educational tasks made possible only through technology [15].

Teachers' transformative actions, categorized as modifications and redefinitions of course content, emphasize utilizing digital technologies to create dynamic activities and collaborative opportunities among colleagues [7]. Illustrative examples include: 1) employing applications like Explain

Everything to capture and illustrate mathematical calculations, and utilizing online simulations to clarify scientific concepts; 2) designing activities that leverage applications such as iTunes U or Explain Everything to support learning progression and enable collaborative knowledge-building between educators and students; 3) facilitating collaboration with peers beyond the confines of a particular educational environment; and 4) engaging in professional reflection via the use of video recordings of classroom activities.

III. Materials and Methods

A. Research Design

This study employed design and development research to develop and validate the scale for optimizing assessment activities through digital technology integration administered by teachers toward transformative learning. This design accommodated three major phases of the study: 1) design and development of the scale, 2) validation, and 3) evaluation.

B. Participants of the Study

The participants of this study consisted of over 130 senior high school teachers at private schools in one of the regions of the Philippines. They were selected based on their engagement in administering assessment activities—whether formative, summative or performance based—that require learners to provide evidence of learning using digital technologies in both online and in-person classes.

C. Instrument

The research instrument or scale, called the scale for optimizing assessment activities through digital technology integration for transformative learning, was developed and validated. It delineates two latent constructs that epitomize transformative learning: modification and redefinition. Each level within these constructs is defined by specific indicators or items, drawn from the literature reviewed.

Tailored for senior high school teachers in the context of the Philippine Basic Education, this scale addresses the pre-existing requirement for students to utilize digital technologies in the learning process. This design aligns with the evolving educational landscape and challenges posed by the pandemic.

D. Data Collection Procedure

The instrument or scale was administered both in person and online to the respondents, who were senior high school teachers from a specific region of the Philippines. A formal letter requesting permission for the administration of the instrument was sent to the principals of the different schools. Alongside the cover page, an informed consent document was provided, outlining the study's purpose and emphasizing that participation was voluntary.

E. Data Analysis

The latent constructs and their indicators were thoroughly analyzed using Exploratory Factor Analysis (EFA) to identify the fundamental factors that affect the optimization of assessment activities through digital technology integration. For the extraction process, principal axis factoring was utilized, along with varimax rotation and Kaiser normalization to improve clarity of interpretation. Prior to conducting the factor analysis, key assumptions were assessed. Due to the varying guidelines in the literature, a sample of 100 senior high school teachers from private institutions in the Philippines was selected. It was. highlighted that these inconsistencies can pose challenges for researchers [32]. Adhering to the recommendations of various studies, a minimum sample size of 100 was established [32]. Furthermore, a sample size of 100 is generally considered sufficient when communalities exceed 0.5, supporting the robustness of the analysis [19].

F. Scope and Limitations of the Study

This study focused on over 100 senior high school teachers from various private schools in a designated region of the Philippines. These educators utilized technology to facilitate formative and summative assessments during and after the pandemic. They had access to necessary equipment and reliable Wi-Fi at home, which supported their online teaching efforts. Additionally, they engaged in training sessions aimed at enhancing their technology integration in education. Conducted over more than a year, the research faced difficulties due to the geographic distances between the participating provinces. Although the intention was to recruit over one hundred participants, some teachers were unable to complete all survey questions, resulting in invalid responses. Furthermore, some educators opted not to participate due to concerns about data privacy.

G. Major Phases of the Study

1) Phase 1—Design and development of the scale

Upon confirming the absence of an existing instrument or scale focused on optimizing assessment activities with digital technology integration for transformative learning, it was determined that the latent factors would be based on the last two stages of Puentedura's SAMR model: modification and redefinition, both of which are conducive to transformative learning.

A comprehensive literature review was undertaken to develop a thorough understanding of these two stages or latent factors. A total of 47 items were generated to serve as indicators for the scale. These items were structured in the form of a five-point Likert scale as outlined below:

- Optimize to a very great extent—5
- Optimize to a great extent—4
- Optimize to a moderate extent—3
- Optimize to a limited extent—2
- Not optimize at all—1

2) Phase 2—Validation

Face validation was conducted by presenting the drafted instrument to a grammarian for grammar checking, formatting, and assessing the appropriateness and consistency of language use. Comments and suggestions from the grammarian were incorporated into editing the scale. For instance, one comment suggested revising Item 4 to read as follows: "I ask my students to submit an output that will connect with other people around the world as part of the learning journey via Facebook, Twitter, and other online platforms."

After reaching face validity, the edited scale underwent content validation. Eight experts specializing in technology integration in teaching and learning, as well as professional education courses, were selected as validators. Each expert was tasked with rating the appropriateness of each item using the following scale:

- 3—appropriate
- 2—needs revision
- 1—reject

The result has an overall mean of 2.56, which indicates that the experts generally accept the indicators in the scale.

3) Phase 3—Evaluation

The revised and validated instrument was administered to over 100 senior high school teachers from a particular region in the Philippines.

The complete Google Forms or printed copies of the instrument were collected and subjected to statistical analysis. Data were analyzed to evaluate each latent factor and its corresponding indicators for internal consistency using Cronbach's alpha. Construct validity for each indicator was assessed using EFA, employing principal axis factoring as the extraction method, and varimax with Kaiser normalization as the rotation method within the factors.

H. Ethical Considerations of the Study

Before administering the questionnaire, respondents were provided with a letter of consent outlining the purpose, benefits, risks, and funding of the study. They were given the opportunity to either agree to participate or decline as respondents. It was emphasized that participation was voluntary, and they had the freedom to withdraw from the study at any point. Throughout the study, respondents remained anonymous because personally identifiable data was not collected, only responses. All the information gathered was kept confidential. Measures were taken to minimize physical, social, psychological, and any other potential harm to the participants.

IV. Result and Discussion

To assess the interrelatedness of each item and its latent constructs, EFA was conducted using principal component analysis and varimax rotation. A minimum factor loading criterion of 0.50 was set. The communalities of the scale, indicating the amount of variance in each dimension, were also evaluated to ensure satisfactory levels of explanation. All communalities were found to be above 0.50.

The essential step of evaluating the overall significance of the correlation matrix was undertaken through Bartlett's test of sphericity, which measures the statistical probability of significant correlations. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (MSA), indicating the appropriateness of the data for factor analysis, was 0.781. MSA values above 0.700 are generally considered suitable for factor analysis.

The factor solution derived from this analysis yielded twelve factors for the scale, which accounted for 72.5% of the variation in the data. However, in this initial EFA, 15 items failed to load significantly on any dimension. One of these was Item 3: "I instructed my students to use a technological tool that makes an abstract concept visible in a hands-on, responsive way (e.g. voyaging on Google Earth to better understand measurement and geography, etc." Two further items loaded onto a factor different from their underlying factor. One of these was Item Q44: "I require my students to submit an analytic thought using multimedia tools." Consequently, these 18 items were removed from further analysis. EFA was repeated without these items, and the results of this new analysis confirmed the seven-construct structure theoretically defined in the research (See Table 1 below).

Table 1. Rotated component matrix

Item number	Component						
	1	2	3	4	5	6	7
24	0.801						
39	0.758						
8	0.713						
27	0.685						
15		0.788					
14		0.720					
31		0.662					
21		0.625					
16		0.596					
46			0.787				
47			0.724				
34			0.632				
38			0.618				
37			0.506				
23				0.772			
22				0.759			
43				0.655			
20				0.554			
32					0.790		
42					0.770		
41					0.753		
33						0.618	
40						0.613	
10						0.600	
12						0.593	
5							0.793
6							0.630

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

After employing the varimax with Kaiser normalization rotation method, the distribution of items across latent constructs was as follows: latent construct 1 comprised items 24, 39, 8 and 27; latent construct 2 comprised items 15, 14, 31, 21, and 16; latent construct comprised items 46, 47, 34, 38, and 37; latent construct 4 comprised items 23, 22, 43, and 20; latent construct 5 comprised items 32, 42, and 41; latent construct 6 comprised items 33, 40, 10 and 12; and lastly, latent construct 7 comprised items 5 and 6 (see Table 1).

A total of 27 items were retained from the original 47-item scale, while 20 items were eliminated for failing to meet the predetermined criteria. Furthermore, the Kaiser-Meyer-Olkin MSA produced a value of 0.798, indicating satisfactory sampling adequacy for the analysis, as depicted in Table 2 below. The seven dimensions collectively accounted for 68.425% of the variance among the items in the study. In addition, Bartlett's Test of Sphericity returned a significant result, affirming the intercorrelation among items, while all communalities exceeded the requisite threshold of 0.500.

To assess the reliability and internal consistency of the items, Cronbach's alpha coefficient was computed for all 27 items distributed across the seven latent constructs. Table 3 below displays the findings, indicating an overall internal

consistency coefficient of 0.911. This value indicates a high degree of internal consistency among the items, suggesting a strong interrelatedness within the item set.

Table 2. KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	**0.798**	
Bartlett's Test of Sphericity	**Approx. Chi-Square**	**1382.548**
	Df	351
	Sig.	0.000

Table 3. Reliability results

Latent Construct	**Cronbach's Alpha**
Creating video presentation	0.817
Using digital platforms	0.832
Utilizing learning management system	0.843
Employing survey administration software	0.823
Using digital art	0.750
Making use of graphic design software	0.607
Requiring social media publishing	0.706
Overall	0.911

The scale underwent further evaluation by administering it to another group of 30 senior high school teachers to assess its reliability and internal consistency. As depicted in Table 4 below, the overall internal consistency coefficient for the 27 items was 0.936, indicating a high level of internal consistency and strong interrelatedness among the items.

Table 4. Reliability results—Second Run

Latent Construct	**Cronbach's Alpha—Second Run**
Creating video presentation	0.758
Using digital platforms	0.738
Utilizing learning management system	0.868
Employing survey administration software	0.755
Using digital art	0.749
Making use of graphic design software	0.733
Requiring social media publishing	0.746
Overall	0.936

Each latent construct is defined as follows:

- Latent construct 1: Creating video presentations, encompassing activities such as collaboratively producing documentary videos and audio recordings to demonstrate learned concepts and for assessment purposes.
- Latent construct 2: Using digital platforms, focusing on tasks like designing e-portfolios, sharing information via blogs, and utilizing word processors for feedback purposes.
- Latent construct 3: Utilizing learning management systems, involving platforms like Google Classroom Canvas Moodle and Schoology for posting reviews, peer feedback, and discussions related to assigned materials.
- Latent construct 4: Employing survey administration software, including the use of tools like Google Forms and documents for submitting and revising written outputs and facilitating feedback
- Latent construct 5: Using digital art, encompassing activities such as creating visual presentations like comic strips, mind maps, and illustrations to summarize concepts and provide interpretations
- Latent construct 6: Making use of graphic design software, involving the utilization of various software tools to create graphs and submit outputs that demonstrate a deeper understanding of the lessons
- Latent construct 7: Requiring social media publishing, including tasks like uploading outputs to various social media platforms to engage digitally with individuals worldwide.

The Scale for Optimizing Assessment Activities with Digital Technology Integration for Transformative Learning was created and validated to motivate educators to improve their instructional practices by incorporating technology. This scale specifically highlights seven key latent factors that play a crucial role in transforming students' learning experiences. These factors determine the degree of technology integration required for effective student assessments; as such, they can serve as valuable reference points for educators seeking to optimize assessment activities, both formative and summative, through digital technology integration, ultimately fostering transformative learning. The latent factors identified here can guide learners in actively constructing meaning in their lives, extending beyond mere concept acquisition [4]. Furthermore, the developed and validated scale offers a practical means for assessing how educators optimize assessment activities.

It is crucial to underscore that optimizing assessment activities through digital technology integration contributes to the enhancement and reform of curricula, teacher practices, learning processes, and achievement standards [24]. Therefore, this study's proposed scale stands as a significant reference point for educators striving to enrich their teaching practices and promote transformative learning outcomes.

V. Conclusion

A validated 27-item scale has been created, grounded in the findings of exploratory factor analysis, to optimize assessment activities through the integration of digital technology, thereby promoting transformative learning. This scale identifies seven distinct constructs: creating video presentations, using digital platforms, utilizing learning management systems, employing survey administration software, engaging in digital art, leveraging graphic design software, and incorporating social media publishing.

Teachers are encouraged to adopt this scale as an assessment tool, ensuring that their formative and summative assessments, integrated with digital technology, facilitate students' demonstration of content mastery, performance proficiency, and 21st-century skills, ultimately fostering transformative learning. Future research should explore how different groups of teachers, from public or private schools, employ digital technologies to enhance educational outcomes, which could inform their professional development. Further studies might also apply confirmatory factor analysis to this scale to refine and strengthen its validity.

Conflict of Interest

The author declares no conflict of interest.

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