

Exploring barriers to gamification implementation in classrooms: an empirical investigation of pre-service teachers' experiences

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ABSTRACT

Gamification has emerged as an effective teaching approach to enhance student engagement and achievement outcomes in the learning process. However, its implementation remains limited due to challenges faced in classrooms, particularly among pre-service teachers, who face unique, understudied barriers in their teaching internships, compounded by insufficient institutional support and inadequate practical preparation. This study employed a quantitative descriptive survey design to investigate the curriculum, resource, and training barriers perceived by pre-service teachers during their internships. A total of 347 pre-service teachers enrolled in the Bachelor of Education (B.Ed.) program participated in the study, after their 16-week teaching internships in secondary schools. Data were collected using a 25-item Likert scale across three barrier dimensions. Descriptive statistics revealed that insufficient mentor guidance constituted the most critical training barrier ($M=3.919$, $SD=1.031$), time constraints dominated resource barriers ($M=3.876$, $SD=1.104$), and mentor adherence to traditional approaches represented the foremost curriculum barrier ($M=3.885$, $SD=1.064$). The results underscore the need for comprehensive reforms in curriculum policy, strengthening technological infrastructure, and redesigning teacher education programs with practical gamification training. Addressing these systemic barriers is essential for preparing future teachers to leverage gamification as a viable teaching methodology in contemporary classrooms.

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1. INTRODUCTION

Gamification has emerged as an innovative teaching approach over the past decade, driven by an ongoing search for ways to make teaching more engaging and enhance learning outcomes. It means incorporating game elements and principles into non-game contexts, such as classrooms, to improve student engagement [1] and support learners' intrinsic motivation [2], [3]. Additionally, it promotes academic achievement [4] and improved learning outcomes. This approach supports the modern educational goal of learner-centric education and the use of technical tools in classrooms [5]. By integrating gamification into classroom teaching, this approach contributes to SDG-4 (quality education) by promoting engagement and learner-centered education. In this context, teachers play a pivotal role in selecting and implementing instructional strategies and resources that effectively engage students in the learning process.

Building on this, many teachers see gamification as an effective strategy for engaging students in the instructional process [6]. However, teachers entirely determine whether gamification is used in the instructional process [7]. Teachers need to be well-trained to make subject-specific adjustments and to align with learning goals [8]. The quality of teachers' preparation decides whether gamification will have a transformative impact or only add minor changes [7]. Teachers' awareness and perceptions, their willingness to innovate, and the training they receive, greatly influence the potential for gamification strategies to be applied in classroom practices [9].

Pre-service teachers are pivotal in implementing new instructional strategies, as they are digital natives who will shape the future of K-12 classroom practice [10]. However, the limited classroom experience of pre-service teachers, combined with institutional constraints during their internship, affects their professional identity [11] and presents unique barriers that pre-service teachers face beyond those encountered by in-service teachers when using gamification in classrooms [12]. This experience is intensified by their role as transitional figures between the theoretical knowledge presented in teacher education programs and the practical nature of pedagogy in the classroom. Finally, pre-service teachers commonly experience a lack of power in decisions about curriculum and technology integration during field placements [13].

However, the existing literature mainly focuses on the impact of gamification on students' outcomes and on practicing teachers in stable classroom contexts; thus, there is a significant gap in understanding the barriers pre-service teachers face during their internships, due to their limited classroom experience. The literature has identified barriers to using gamification in classroom research [14], and it classifies them into the following problem categories: i) barriers related to curriculum; ii) barriers related to resources; and iii) barriers related to training for implementing gamification in the classroom. To overcome these obstacles, teachers must have enough knowledge of gamification techniques [15]. A significant gap exists in empirically examining the barriers pre-service teachers face in internships. Understanding the barriers pre-service teachers face is essential to preparing future teachers to implement gamification effectively in classrooms.

This study aims to empirically explore curriculum, resource, and training barriers from the perspective of pre-service teachers during their 16-week internship in Telangana, India. The novelty of this study lies in its focus on an underexplored geographic and institutional context within gamification research. Unlike many earlier studies that mainly focused on students, this research is grounded in real classroom internship experiences and captures the practical implementation challenges faced by pre-service teachers. In addition, it simultaneously examines curriculum-, resource-, and training-related barriers, providing a comprehensive understanding of the key challenges pre-service teachers encounter while implementing gamification. Overall, the study bridges theory and practice and offers useful insights for improving teacher education and training programs in India.

Therefore, the present study provides descriptive empirical evidence on the barriers pre-service teachers face when they use gamification as a teaching method. The study identifies the curriculum, resource, and training barriers that hinder pre-service teachers from using gamification in classroom teaching. The findings offer empirical insights to revise the curriculum to incorporate innovative teaching methods, strengthen resource availability in schools, and develop professional training programs that enhance pre-service teachers' competency in the effective use of gamification.

The significance of this study extends beyond academic contribution to practical and policy-level implications for teacher education. At the institutional level, the study can inform curriculum designers and administrators in redesigning their Bachelor of Education (B.Ed.) programs to ensure that gamification is part of the core pedagogical knowledge base for all pre-service teachers. At the school system level, the evidence presented here can inform policymakers in similar contexts to set minimum technological infrastructure standards for schools that host pre-service teacher internships. Furthermore, the findings highlight the need for cooperating or mentor teachers in partner schools to receive targeted professional development so they are equipped to guide and support pre-service teachers in experimenting with innovative teaching methods.

Thus, the objectives of this study are to identify the curriculum barriers, identify the resource barriers, and identify the training barriers that limited the pre-service teachers from effective implementation of gamification in classrooms. These objectives address a critical gap in the existing literature on pre-service teacher preparation for gamification by providing new empirical evidence on curriculum, resource, and training barriers that limit pre-service teachers' ability to implement gamification effectively in classrooms. Addressing them will contribute empirical insights to inform policy and curriculum reform in teacher education programs. Based on the objectives, the study aimed to address these questions:

- What curriculum barriers limited the pre-service teachers from using gamification in their teaching internship?
- To what extent does the availability of resources influence the pre-service teachers' use of gamification in teaching?
- What training-related barriers prevent pre-service teachers from effectively using gamification in teaching?

2. LITERATURE REVIEW

2.1. Theoretical framework

Self-determination theory (SDT) [16] provides an additional perspective on how barriers might be addressed. It suggests that there are three psychological needs: autonomy, competence, and relatedness that must be met to support intrinsic motivation. Gamification in a classroom must address the needs of both teachers and learners [17]. When psychological needs are not met, psychologists have indicated that teachers' acceptance of the method and learners' participation in gamification decrease.

Further, gamification in education can be understood as the integration of game mechanics or elements in classrooms to engage learners and achieve intended outcomes [18]. According to the literature, gamification offers an immersive learning experience in classroom instruction [19]. When using an experiential learning approach, gamification facilitates students' conceptual knowledge by allowing them to apply what they have learned through practical experiences and reflections. It is built upon Kolb's experiential learning theory, which posits that significant learning occurs through active participation in everyday life [20]. In this regard, gamification aligns perfectly with the game elements, as repeated attempts, instant feedback, decision making, and the ability to adjust one's approach naturally support each stage of this learning process [21].

Also, the gamification approach is based on the technology-pedagogy-content knowledge (TPACK) framework [22]. The TPACK model offers an integrative approach that brings together three critical components: technology, pedagogy, and content, to embed technological tools within instructional practices effectively. Problems arise for pre-service teachers when these domains do not come together. Evidently, technical barriers reveal a lack of knowledge in technological knowledge (TK), training barriers reveal a lack of knowledge in pedagogical knowledge (PK), curriculum barriers demonstrate a lack of content knowledge (CK), and engagement barriers take place when the integration of TPACK does not actively engage students.

2.2. Conceptual framework

2.2.1. Curriculum-related barriers

Curriculum barriers hinder teachers and schools from fully implementing gamification. These are structural barriers established by the schools or policies. Pre-service teachers experience these barriers more severely, as they encounter them during teaching practice through their cooperating teachers' lesson plans and the school's pacing guide [23]. Research suggests standardized content requirements (i.e., the requirements of a mandated curriculum and pace) limit the capacity to adopt creative and innovative teaching methods in classroom instruction [24].

Additionally, a notable obstacle is aligning the game mechanics with the learning goals outlined in the curriculum [25]. The standardized testing mindset creates additional curriculum challenges, as many perceive gamification activities as taking valuable time away from test preparation, limiting teachers' ability to use innovative methods in classroom instruction [26]. On the other hand, pre-service teachers share that their mentor teachers often discourage the use of creative teaching practices as outlined in the curriculum [27].

Subject-based limitations also arise, primarily because gamification is perceived as more accessible in STEM than in humanities disciplines [28], resulting in inequitable access across disciplines. Mathematics and science teachers reported being more comfortable with gamifying content through problem-solving challenges and simulations than language arts and social studies teachers, who reported difficulty identifying effective implementation mechanics [29]. Additionally, heavy content loads in subject areas leave little room for the repeated implementation and exploration that gamified learning experiences require [30].

2.2.2. Resource barriers

The use of gamification may face barriers related to infrastructure or limited resources. The literature suggests that inadequate digital resources, unreliable Wi-Fi connections, and other factors provide substantial barriers to implementing gamification in classrooms [31]. A pre-service teacher would be especially challenged because they lack authorization to access digital resources and must use school resources during their field placements [32]. The digital divide is evident, as schools have unequal access to technology across varying socioeconomic communities [33]. Even with hardware, software costs, and school guidelines, pre-service teachers' choice of gamification is restricted [34]. Many schools block gaming websites and applications for educational purposes, as these sites are restricted by an internet filter that limits access to gamification platforms such as Kahoot, Quizizz, or Classcraft.

Technical literacy presents another substantial challenge. Although pre-service educators are often referred to as digital natives [35], their proficiency with consumer-oriented technologies does not transfer to pedagogical use of technology [32]. Developing gamified learning experiences requires a level of technical literacy beyond digital literacy, including understanding the mechanics of games, customizing platforms, using data analytics to track student learning, and resolving technical issues [36].

In addition, the lack of technical support staff within schools impedes troubleshooting, and, ultimately, responsibilities fall back on teachers. Their time is wasted instead of being allocated to instruction [37]. Pre-service teachers consistently report feeling unable to mitigate technical device failures during instruction, such as crashes, login issues, or incompatible devices [38]. Facing a technical failure in front of students and their mentor teachers heightens their anxiety and reduces the likelihood of integrating technology and gamification [32].

2.2.3. Training barriers

Limited preparation in gamification as a pedagogical tool is a significant challenge to implementation. Teacher education programs typically provide little experience with game-based learning design principles [39]. Studies indicate that pre-service teachers need structured experiences that cover gamification theory, game design principles, and the practical experience of implementing gamification strategies. Nevertheless, teacher education programs typically only cover gamification as a superficial or irrelevant idea, if they discuss it at all [40].

The distinction between conceptual knowledge and knowledge-in-action becomes most apparent in field experiences. Pre-service teachers may claim to understand the concept of gamification, yet struggle to translate this knowledge into lesson plans aligned with curricular standards [41]. This lack of connection highlights insufficient development of pedagogical content knowledge (PCK) tailored to game-based learning. Likewise, designing authentic gamified learning experiences for students is far more complex than basic pedagogical knowledge. Instead, it requires understanding how game constructs align with specific learning objectives in the content [29].

The lack of mentorship from skilled gamification practitioners exacerbates the training issues [42]. Few cooperating teachers in schools during their internships have any background in gamification, thereby providing little role modeling or guidance for pre-service teachers [32]. This creates a confusing situation in which pre-service teachers are asked to innovate beyond their mentors' practices without sufficient support structures [43].

Professional development options that support gamification have not been widely available [44]. When professional development is available, it tends to focus on the gamification platforms (the technology itself) rather than on the pedagogical principles that allow teachers to apply different pedagogical strategies in different contexts [45]. In addition, pre-service teachers do not have the opportunity to observe firsthand the successful application of gamification in real-life classroom settings; therefore, they lack access to a practical model [46]. If pre-service teachers do not have the opportunity to observe an experienced teacher navigating issues related to balancing competition, game difficulty, or assessment of learning in gamified scenarios, it becomes more challenging for them to envision doing the same in their own teaching.

3. RESEARCH METHOD

3.1. Research design

The current study used a quantitative research paradigm under a descriptive survey design to investigate the pre-service teachers' constraints when implementing gamification strategies during their teaching internship. Quantitative methods were used to collect and analyze data. Quantitative data collection uses measurable variables and statistical procedures to determine relationships in numerical data [47]. This approach was chosen to identify barriers in pre-service teachers' experience with gamification strategies. One of the strengths of using quantitative methods is to gather measurable data that can later be analyzed statistically.

3.2. Sample selection criteria

The study population comprised all student teachers enrolled in the B.Ed. program in Telangana, India. The study adopted a multi-stage sampling technique to ensure sample representativeness. At the primary stage, 7 teacher education institutes were identified offering B.Ed. program affiliated with Kakatiya and Satavahana universities using convenience-based cluster sampling based on accessibility. In the second stage, data were collected from pre-service teachers who used a gamification strategy in their teaching during the internship, using a purposive sampling technique. A total of 347 pre-service teachers participated in this study from various teacher education institutions in the state of Telangana, India. This sample size is considered adequate for quantitative descriptive survey research of this scope, as prior methodological guidelines recommend a minimum of 200–300 respondents for survey-based studies examining multiple constructs across distinct subgroups [47]. All participants were in the third semester of the B.Ed. program and were completing their teaching internship in secondary schools. The study participants numbered 347, comprising 262 females (75.50%) and 85 males (24.50%). The pre-service teachers used gamification

strategies in their classrooms throughout a 16-week internship. Table 1 presents the demographic profile of the 347 participants, including gender distribution and university affiliation.

Table 1. Demographic data of sample (N=347)

SN	Variable	Value	Frequency	Percentage (%)
1.	Gender	Male	85	24.50
		Female	262	75.50
2.	University	Kakatiya University	212	61.10
		Satavahana University	135	38.90

To ensure methodological transparency in the respondent selection process, the data were collected after participants completed their secondary school internships. Participants who had completed a 16-week teaching internship in a secondary school and had used at least one gamification approach during that internship were included in the study. In contrast, pre-service teachers who had not implemented any form of gamification during their internship, as well as those with incomplete or partially filled questionnaire responses, were excluded from the analysis.

The Likert Scale [48] was utilized in the questionnaire design, offering responses from 1 (strongly disagree) to 5 (strongly agree). Participants responded to 25 items, grouped into three distinct parts. Section A focused on challenges connected to the school curriculum (11 items). Section B addressed issues linked to insufficient resources (6 items), and section C examined barriers related to training (8 items). Each participant responded to the questionnaire independently.

JASP software (version 0.95.4) was utilized to analyze the data collected from participants. This tool was found suitable because it delivers clear statistical outputs while effectively managing both demographic variables and participant perceptions. The analytical approach incorporated descriptive statistics, including percentages (%), mean values (M), and standard deviations (SD), to evaluate agreement levels across various barrier dimensions.

4. RESULTS

This section presents the findings from a questionnaire completed by 347 pre-service teachers, which explored the obstacles they encountered when applying gamification strategies during their teaching internship. The results are organized into three subsections: curriculum barriers, resource barriers, and training barriers encountered by the pre-service teachers in their classroom instruction. Each subsection presents descriptive statistics alongside theoretical interpretations to provide a comprehensive understanding of the barriers pre-service teachers encountered during their 16-week internship.

4.1. Curriculum-related barriers

Table 2 presents the curriculum-related barriers pre-service teachers face when implementing gamification during their teaching practice. Across all 11 items, mean scores ranged from 3.744 to 3.885, indicating uniformly high agreement and a systemic pattern of constraint. Structural and time-related curriculum constraints emerged as consistently significant barriers across multiple items.

Pre-service teachers reported that the sequential nature of curriculum topics ($M=3.841$, $SD=1.062$), the rigid structure of the school curriculum ($M=3.749$, $SD=1.127$), heavy content coverage requirements ($M=3.758$, $SD=1.130$), and insufficient time allocated by curriculum pacing guides ($M=3.790$, $SD=1.117$) all substantially hindered their ability to integrate gamification during their internship. A large number of pre-service teachers agreed or strongly agreed with each of these statements, showing that these constraints were widely shared across the sample. These results collectively point to a common theme in educational research: the need to reconcile a standardized curriculum and pacing guides based on accountability with the iterative nature of player-driven progression systems required for effective gamification, while giving teachers the time to translate pedagogical theory into innovative classroom practice [29], [49]–[51].

Curriculum alignment and assessment-related barriers were equally pervasive among the respondents. Pre-service teachers reported difficulty integrating gamification due to standardized testing pressures ($M=3.821$, $SD=1.116$), the absence of curriculum guidance on game-based pedagogies ($M=3.787$, $SD=1.078$), challenges in aligning learning outcomes with gamification elements ($M=3.807$, $SD=1.151$), and prescribed textbooks that did not support gamified approaches ($M=3.821$, $SD=1.149$). These assessment methods conflicted with gamification formats ($M=3.744$, $SD=1.118$), and curriculum objectives that were too broad for effective gamification implementation ($M=3.816$, $SD=1.143$). The very similar mean scores for these six items indicate that these barriers are structural rather than individual and embedded in the school

curriculum. These findings suggest that the conditions of high-stakes testing, conventional teaching resources and inflexible assessment requirements compound and limit pre-service teachers' ability to innovate and practice with new pedagogies, such as gamification, in their placements [1], [25], [26], [51], [52].

The most significant curriculum barrier was the statement "My mentor teacher's adherence to traditional curriculum approaches limited my ability to experiment with gamification," which showed the highest mean of 3.885 (SD=1.064). About 67.15% of pre-service teachers agreed with this statement, showing that mentor teachers had a strong influence on limiting the use of gamification in classrooms. This finding suggests that many mentor teachers prefer traditional teaching methods and often discourage student teachers from trying innovative approaches that differ from regular classroom methods and curriculum expectations [53]. Such resistance from mentor teachers places pre-service teachers in a professionally vulnerable position, where the desire to experiment with innovative methods conflicts with the mentor teacher's institutional authority. These findings suggest that teacher education programs should develop structured mentorship frameworks that explicitly encourage mentor teachers to guide pre-service teachers in implementing innovative practices during their internships.

Table 2. Curriculum barriers in gamification implementation

SN	Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	SD
1	The sequential nature of curriculum topics made it challenging to design progressive gamified experiences.	16	15	86	121	109	3.841	1.062
2	The rigid structure of the curriculum at school limited my flexibility to incorporate gamification.	19	20	100	98	110	3.749	1.127
3	Heavy curriculum content coverage requirements restricted the time available for gamified activities.	21	19	90	110	107	3.758	1.130
4	Standardized testing pressures made it difficult to integrate gamification into lessons.	17	22	84	107	117	3.821	1.116
5	The curriculum at school did not provide guidance on integrating game-based pedagogies.	16	21	87	120	103	3.787	1.078
6	Learning outcomes specified in the curriculum were difficult to align with gamification elements.	22	19	80	109	117	3.807	1.151
7	The prescribed textbooks and materials at school did not support gamified learning approaches.	22	20	73	115	117	3.821	1.149
8	Curriculum pacing guides left insufficient time for implementing gamification strategies.	19	16	98	100	114	3.790	1.117
9	Assessment methods mandated by the curriculum conflicted with gamification assessment approaches.	23	14	92	118	100	3.744	1.118
10	The curriculum objectives of the school were too broad to be effectively addressed through gamification.	23	13	87	106	118	3.816	1.143
11	My mentor teacher's adherence to traditional curriculum approaches limited my ability to experiment with gamification.	14	17	83	114	119	3.885	1.064

4.2. Resource barriers in gamification implementation

The resource barriers explore the impact of resource scarcity on pre-service teachers' use of gamification as an alternative pedagogical approach in the classroom. Schools in low-resource contexts, especially those serving lower socioeconomic groups, mirror the digital divide highlighted in the literature, where limited access to technology restricts teachers' pedagogical choices [33]. Table 3 presents the resource-related challenges that pre-service teachers faced while attempting to incorporate gamification into their teaching practice.

Infrastructure and access-related resource barriers were consistently reported across five items, all recording mean scores above 3.73, indicating high levels of agreement among respondents. Pre-service teachers identified inadequate technological devices such as computers and tablets (M=3.841, SD=1.062), poor internet connectivity that restricted access to online gamification platforms (M=3.801, SD=1.119), the absence of ready-made gamification materials and resources (M=3.801, SD=1.124), limited classroom space for conducting gamification activities (M=3.732, SD=1.195), and restricted access to digital software, applications, and platforms (M=3.784, SD=1.129) as significant obstacles to implementation. The high agreement between the mean scores for these items indicates that infrastructure deprivation is a systemic phenomenon. Overall, these findings demonstrate that pre-service teachers work in systemically resource-

deprived school contexts that prevent the adoption of gamification regardless of motivation and ability, paralleling the digital divide and institutional constraints documented extensively in the broader educational technology literature [54]–[56].

Among all resource barriers, time constraints emerged as the most significant. The statement “time constraints limited my ability to develop and implement gamification strategies” received the highest number of strongly agree responses (125), with a mean of $M=3.876$ ($SD=1.104$), indicating that time was the most significant resource barrier identified in this study. These findings align with Lester *et al.* [14], whose PRISMA-based systematic review of educators’ perspectives identified time constraints as one of the most consistently reported design-related and administrative barriers to gamification adoption, reflecting the reality that planning and developing gamified activities place considerably greater demands on teachers than conventional lesson preparation. Taken together, the resource barriers identified in this study, ranging from inadequate technological devices and poor internet connectivity to the absence of ready-made materials and persistent time constraints, collectively reveal that pre-service teachers operate within resource-deprived environments that structurally impede gamification adoption, regardless of their own interest in the approach.

Table 3. Resource barriers in gamification implementation

SN	Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	SD
1	My school does not have adequate technological devices (computers, tablets) to implement gamification strategies effectively.	16	12	95	112	112	3.841	1.062
2	Poor internet connectivity in my school limits the use of online gamification platforms.	21	12	96	104	114	3.801	1.119
3	Lack of ready-made gamification materials and resources hindered implementation.	19	20	86	108	114	3.801	1.124
4	Limited classroom space affects the implementation of gamification activities.	27	20	84	104	112	3.732	1.195
5	Limited access to digital resources (software, applications, platforms) hinders my ability to use gamification in teaching.	22	15	89	111	110	3.784	1.129
6	Time constraints limited my ability to develop and implement gamification strategies.	17	16	85	104	125	3.876	1.104

4.3. Training barriers in gamification implementation

The training barriers explore how insufficient preparation and lack of practical guidance affected pre-service teachers’ ability to use gamification as an innovative teaching approach in the classroom. Limited training opportunities and inadequate exposure to gamification strategies reduced their confidence and their ability to effectively implement these strategies during teaching practice. Table 4 presents the training-related challenges pre-service teachers face when attempting to incorporate gamification into their teaching practice. The two highest-rated items across the entire study of 25 items were both found in this category. Insufficient mentor teacher guidance on implementing gamification ($M=3.919$, $SD=1.031$) was the single highest-rated barrier in the entire study, and inadequate program training on gamification strategies ($M=3.890$, $SD=1.067$) was the second highest, indicating that both field-based mentorship and program-level preparation fail to adequately support gamification implementation. These findings reflect documented gaps in teacher preparation programs, which often struggle to keep pace with emerging pedagogical innovations, leaving graduates inadequately prepared to implement contemporary instructional approaches such as game-based learning [23], and are consistent with research demonstrating that mentor teachers typically focus on classroom management and traditional methods while providing limited guidance on contemporary approaches such as technology-enhanced and game-based learning [53].

Beyond mentorship gaps, pre-service teachers also identified significant deficiencies across six additional dimensions of training preparation. The absence of practical examples of successful gamification in teacher education programs ($M=3.836$, $SD=1.039$), insufficient training on specific gamification platforms and tools ($M=3.810$, $SD=1.106$), and inadequate preparation for troubleshooting technical issues during instruction ($M=3.784$, $SD=1.065$) were all rated as considerable barriers. Notably, training in assessing student learning within gamified environments and training in aligning gamification with curriculum objectives were rated with equal urgency ($M=3.778$ for both, with $SD=1.145$ and $SD=1.104$), indicating that teacher preparation programs must address both areas simultaneously rather than prioritizing one over the other. The lack of collaborative peer-learning opportunities further compounded these preparation gaps ($M=3.764$, $SD=1.113$). In summary, the six identified barriers converge around a common theme: teacher education programs expose pre-service teachers to a theoretical understanding of gamification without offering

the practical, applied skills, including tool use, assessment, curriculum integration and collaboration skills needed to implement gamification in the classroom knowledgeably and effectively [22], [45], [52], [57].

Table 4. Training barriers in gamification implementation

SN	Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	SD
1	My teacher education program did not provide adequate training on gamification strategies.	13	16	92	101	125	3.890	1.067
2	I did not receive sufficient guidance from my mentor teacher on implementing gamification.	12	11	94	106	124	3.919	1.031
3	My teacher education program did not include practical examples of successful gamification implementation.	11	23	85	121	107	3.836	1.039
4	Lack of training on specific gamification platforms and tools hindered my implementation.	21	13	86	118	109	3.810	1.106
5	I did not receive training on how to assess student learning in gamified environments.	19	22	94	94	118	3.778	1.145
6	Insufficient training on aligning gamification with curriculum objectives created challenges.	19	19	87	117	105	3.778	1.104
7	Lack of collaborative learning opportunities with peers about gamification limited my preparation.	18	19	100	100	110	3.764	1.113
8	My teacher training program did not prepare me to troubleshoot technical issues with gamification tools.	17	17	89	125	99	3.784	1.065

5. DISCUSSION

The current study examined the curriculum, resource, and training barriers perceived by 347 pre-service teachers during their 16-week teaching internships, revealing consistently high mean scores across all 25 items (ranging from 3.732 to 3.919), indicating that these are not individual readiness failures but rather systemic institutional constraints that structurally prevent the implementation of gamification during internships [14]. Viewed through the TPACK framework [22], the three barrier dimensions collectively reflect a tripartite knowledge deficit encompassing CK, TK, and PK. At the same time, the SDT [16] further explains how the absence of autonomy and competence support during internships undermines pre-service teachers' confidence and willingness to use innovative teaching approaches.

Curriculum barriers emerged as a clash between content-focused, fixed school curricula and the flexible, iterative nature of gamified design, directly reflecting a CK deficit in which pre-service teachers' ability to adapt subject matter for innovative delivery is undermined by curricular over-prescription [24]. This is consistent with Kang [27], who documented that mentor teachers' resistance to innovative approaches directly undermines the autonomy dimension of SDT, as pre-service teachers who are discouraged from experimenting lose the psychological freedom essential for trying new pedagogies. The findings align with Okafor [26], who stated that high-stakes testing environments significantly reduce teachers' capacity for pedagogical innovation, a pattern strongly reflected in this study's assessment-related curriculum barrier items.

Resource barriers directly reflect a TK deficit within the TPACK framework, as pre-service teachers cannot develop technological knowledge in environments where devices are inadequate, the internet is unreliable, and platforms are blocked [33]. The digital divide documented by Kem [33] and the infrastructure constraints reported by Muruga and Jamaludin [31] closely mirror the resource patterns identified in this study, where five infrastructure items all recorded mean scores above 3.73. Critically, time constraints emerged as the single most significant resource barrier ($M=3.876$), aligns with Lester *et al.* [14], who identified time as the most consistently reported administrative barrier to gamification adoption across educational contexts.

Training barriers revealed that pre-service teachers are not receiving the practical, applied training they need to implement gamification, despite teacher education programs' emphasis on theoretical content [39], [45]. This reflects a PK deficit, as cooperating teachers lacking expertise in game-based learning defaulted to supervising conventional teaching rather than modelling or facilitating innovation, consistent with Clarke *et al.* [53], who found that cooperating teachers rarely provide guidance on innovative pedagogical strategies beyond their own existing repertoire. In contrast to prior studies focused on in-service teachers in higher-resource settings [12], [32], this study demonstrates that in a developing-country internship context, all three TPACK deficits are simultaneously active, creating a compounding dynamic that structurally prevents gamification adoption regardless of individual teacher motivation or ability [43], [44].

Based on the findings, several recommendations are directed at key stakeholders. State education authorities should update curriculum frameworks to create explicit allowances in timetables and pacing

guides for innovative pedagogical approaches such as gamification, and formally recognize game-based teaching as a valid approach aligned with learning outcomes [7]. B.Ed. programs should redesign practicum components to include structured, practice-based gamification modules covering platform use, assessment design, and curriculum alignment, moving beyond theoretical exposure to applied preparation. Partner school principals and district education offices should mandate professional development for cooperating mentor teachers to support rather than constrain pre-service teacher innovation during internships [27], [53]. Finally, governments and affiliated universities should mandate minimum digital infrastructure standards as a prerequisite for schools seeking approval as internship partner institutions.

6. CONCLUSION

This research provided empirical evidence on the curriculum, resource, and training obstacles that pre-service teachers face when applying gamification in their 16-week teaching internships. Overall, pre-service teachers are working in systems that do not support the flexible, iterative, technologically enabled nature that gamification requires. The primary barriers identified were institutional rather than motivational, rooted in mentor dependency, curriculum rigidity, and resource scarcity, rather than in pre-service teachers' personal willingness or capability. Viewed through TPACK and SDT, these findings confirm a tripartite knowledge deficit compounded by a lack of autonomy and competence support during field placements, underscoring the need for systemic reform across curriculum, infrastructure, and teacher preparation simultaneously.

The study has some limitations. It used descriptive statistics and pre-service teachers' self-reported opinions from selected teacher education institutions in Telangana, which may limit the generalizability of the findings to other geographical contexts. Also, the research did not examine pre-service teachers' qualitative insights to deepen understanding of the identified barriers. Future research could employ inferential statistics and mixed-methods approaches to explore relationships among variables and provide a deeper understanding of the barriers faced by pre-service teachers. Expanding the study across different states and regions of India would improve the generalizability of the findings. In addition, longitudinal studies should investigate whether early exposure to gamification practicum modules during B.Ed. programs produce sustained improvements in pre-service teachers' implementation competencies across diverse school contexts.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nterpretation

R : **R**esources

D : **D**ata Curation

O : **O**riginal Draft

E : **E**diting

Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

DATA AVAILABILITY

Derived data supporting the findings of this study are available from the corresponding author [AS] on request.

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