
**Authentic Assessment of Creativity, Collaboration, and Problem-Solving in STEAM Classrooms:
Insights from a Phenomenological Study of Teachers in Pakistan**

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Abstract

This paper examined the lived experiences of STEAM teachers who use authentic assessment to evaluate creativity, collaboration, and problem-solving as 21st-century competencies. The study utilized qualitative research method and phenomenological design. The sample consists of six STEAM secondary teachers, and data was collected through semi-structured interviews. Thematic analysis was carried out to analyze the data, resulting in three general themes. First, teachers reported using real-world tasks, project activities, collaborative inquiry, and locally produced rubrics to assess applied knowledge. Second, participants identified major obstacles, including curriculum overload, exam pressure, limited resources, lack of assessment literacy, lack of institutional support, and workload. Third, teachers discussed adaptive strategies such as integrating projects into syllabus topics, adjusting rubrics over time, utilizing digital tools, engaging in self-directed professional development, and seeking support from peers and administrators. The findings highlight the importance of authentic assessment in capturing integrated competencies in STEAM education and emphasize the need for institutional reforms in teacher education, school leadership, curriculum policy, and assessment system to effectively implement authentic assessment. In conclusion, this paper asserts that authentic assessment is crucial for evaluating.

Keywords: Authentic Assessment, STEAM Education, Creativity, Collaboration, Problem-Solving, Phenomenology, 21st-Century Competencies.

1. Introduction

There has been a significant transformation in education assessment systems over the past few decades. The educational demands of the world community now place more emphasis on developing of comprehensive skills rather than memorizing information. Traditional standardized testing systems have proven inadequate for evaluating higher-order thinking, real-world and interdisciplinary outcomes effectively. These techniques focus on learning in isolation and do not reflect of how students can apply their learning in practical contexts (Pellegrino, 2016). As a result, educators and researchers are increasingly adopting authentic assessment as a contextually-focused and holistic method of evaluating student learning (Care & Kim, 2017; Pellegrino, 2016; Vlachopoulos & Makri, 2024). The shift towards authentic assessment is crucial, aligning with the growing importance of assessing 21st-century competencies within the science and interdisciplinary education framework (Juanda, 2022).

Authentic assessment relies on real-world tasks, performance-based assessments, and meaningful problem solving experiences to capture authentic learning activities (ElSayary, 2021a; Tan and Kidman, 2021;

Vlachopoulos and Makri, 2024). Unlike traditional testing systems, it emphasizes students' application of knowledge in real life situations and encourages collaboration in group work (Vlachopoulos & Makri, 2024). This shift directly correlates with the prioritization of 21st century competencies, in particular creativity, collaboration, and problem-solving, as essential skills preparing learners to work in the complex, fast-changing world (Care & Kim, 2017; Thornhill-Miller et al., 2023).

The concept of authentic assessment is particularly relevant to the interdisciplinary fusion in the field of STEAM learning, which is the primary pedagogical priority. Creative, social, and cognitive skills are used simultaneously, requiring the integration of science, technology, engineering, arts, and mathematics (STEAM) in classrooms (Chen and Ding, 2025). Consequently, evaluation strategies in such environments should shift towards integrated competencies' assessment instead of employing fragmented methods of measurement. Despite the growing popularity of authentic assessment, there are still conceptual ambiguities, practical problems and structural limitations that suggest the need for further research and development efforts in this area.

Although authentic assessment is theoretically promising and applied in STEAM classrooms, its concrete realization especially in terms of the integrated evaluation of creativity, collaboration, and problem-solving continues to be scarcely known. A large part of the current literature is abstract or theoretical in nature and empirical studies that explore how teachers go about the actual implementation of authentic assessment of these competencies in the real classroom environment are limited (Chen and Ding, 2025; Thornhill-Miller et al., 2023). What has received little systematic attention however are the problems faced by teachers in the implementation process and how teachers devise strategies to counter these.

This gap is particularly noticeable in non-Western educational settings. Most of the literature on this topic has focused on Western institutional contexts, leading to significant gaps in understanding the relevance of authentic assessment systems in diverse socio-cultural settings such as in the case of Pakistan. While curriculum change agendas in Pakistan are increasingly focused on integrating 21st century competency aspirations, there is a lack of empirical support for these initiatives (Evans & Taylor, 2025). The proposed study thus intends to fill these gaps by empirically examining the experiences of STEAM teachers through a qualitative phenomenological investigation. This approach provides a contextually grounded understanding of the practices, barriers to implementation, and adaptive strategies in this context.

Research Questions

This study is guided by the following research questions:

RQ1: How do STEAM teachers implement authentic assessment to evaluate creativity, collaboration, and problem-solving competencies?

RQ2: What challenges do STEAM teachers experience when implementing authentic assessment for these competencies?

RQ3: What strategies do STEAM teachers use to address these challenges?

2. Literature Review

2.1 Conceptual Foundations of Authentic Assessment and Integrated Competencies

2.1.1 Defining Authentic Assessment in STEAM Education

The principle of authentic assessment is based on the idea that traditional system of assessment fails to reflect the rich outcome of learning. According to Pellegrino (2016), traditional tests mainly focus on discrete knowledge rather than on students' ability to apply what they have learned in real-life situations. Similarly, Vlachopoulos and Makri (2024) have found that performance-based assessment is more effective in capturing the development of competencies in a practical manner, compared to other standardized testing approaches.

The multidimensionality of 21st-century competencies is a theoretical concept discussed in the literature.

Research conducted by Care and Kim (2017) examined the validity of measuring contemporary skills and asserted that creativity, collaboration, and problem-solving skills are not independent variables but are highly correlated with each other. Thornhill-Miller et al. (2023) have also studied the measurement and certification of future work skills, noting that the skills work together in more complex learning settings. This interconnectedness is emphasized in the framework of STEAM education. The study by Chen and Ding (2025) discusses the assessment of competence in STEAM learning, with a focus on the interdisciplinary nature of these environments where students must integrate knowledge from different disciplines. Likewise, Aghazadeh (2019) explored frameworks for evaluating 21st-century skills and identified consistent gaps in theoretical knowledge regarding the definition and classification of competencies.

2.1.2 Traditional versus Authentic Assessment

In literature, the comparison of traditional and authentic assessment methods is significant. Traditional practices focus on memorization and individual learning processes, which may not effectively develop higher-order thinking skills (Pellegrino, 2016; Care & Kim, 2017). In contrast, authentic assessment emphasizes contextualized learning where students demonstrate understanding through real life scenarios and interdisciplinary tasks (Vlachopoulos & Makri, 2024).

However, despite these potential benefits, literature also acknowledges the conflict between authenticity and scalability. While authentic assessment provides more insights into student learning, it can be challenging to implement, on a large scale, leading to issues of consistency, standardization, and applicability in broader settings (Vlachopoulos & Makri, 2024; Pellegrino, 2016). These contradictions highlight the need to address the pedagogical benefits of authentic assessment while also recognizing the challenges of integrating it into formal education systems.

2.1.3 Cross-Disciplinary Competency Evaluation in STEAM

The complexity of STEAM education is also contributed by the fact that this learning process is interdisciplinary, making assessment practices even more complicated. STEAM education must combine scientific, technological, engineering, artistic, and mathematical literacy while also incorporating intellectual, interpersonal, and imaginative skills (Chen & Ding, 2025; Herro et al., 2017). This integration makes it challenging to analyze competencies separately, as performance is often an indicator of the interplay of various skills areas.

Aghazadeh (2019) identified gaps in the definitions and classification of these competencies across the different fields, making it difficult to develop common assessment models. Additionally, Care and Kim (2017) noted that current assessment models often do not capture the interconnected nature of 21st-century competencies. These limitations highlight the need to create more holistic and flexible assessment methods that account for the complexity of interdisciplinary learning environment.

Table 1. Key Studies on Authentic Assessment in STEAM Education

Author(s)	Year	Focus of Study	Method/Approach	Key Findings
Care & Kim	2017	Authentic assessment of 21st-century competencies	Conceptual analysis	Creativity, collaboration, and problem-solving are interrelated and difficult to measure independently
Pellegrino	2016	Future of science assessment	Theoretical framework	Assessment should measure application, transfer, and real-world knowledge use

Herro et al.	2017	Collaboration assessment in STEAM	Empirical framework in development	Peer evaluation and rubrics improve teamwork assessment
Lin et al.	2015	Collaborative problem-solving assessment	Digital assessment system	Technology can track communication and participation patterns
Tan & Kidman	2021	Authentic assessment in STEM education	Case analysis	Real-world tasks enhance conceptual understanding and skill integration
Thornhill-Miller et al.	2023	Assessment of 21st-century skills	Review study	Creativity and collaboration remain difficult to quantify consistently
Vlachopoulos & Makri	2024	Authentic assessment in higher education	Systematic literature review	Authentic tasks support development of complex competencies

Source(s): Author's own work

2.2 Authentic Assessment Practices for Creativity, Collaboration, and Problem Solving

Authentic assessment in STEAM education aims to evaluate more intricate and interconnected competencies through performance-based tasks that are contextually meaningful. These practices align with the assessing 21st century skills, which are often referred as the 4 Cs; creativity, collaboration, critical thinking, and communication (Hamdu et al., 2020). Within the STEAM framework, these competencies are not evaluated in isolation but are integrated into interdisciplinary tasks that require the application of multiple skills simultaneously.

2.2.1 Measuring Creativity in STEAM Classrooms

The assessment of creativity in STEAM education has primarily focused on process and performance measures. ElSayary (2021b) suggested that transdisciplinary STEM programs which are project-based and inquiry-based, are effective in evaluating students' innovation and creative thinking. Similarly, Irma et al. (2023) found that problem-based learning incorporating digital authentic assessment, can significantly enhance students' scientific creativity. Research also emphasizes the importance of evaluating the creative process, not just the final results. Hsu et al. (2023) emphasized the need to capture ideation, reflection, and iterative development, while Thornhill-Miller et al. (2023) added that existing tools often focus on final products rather than mental processes like originality and flexibility.

2.2.2 Assessing Collaboration in STEAM Contexts

Teaching STEAM involves collaboration as a primary aspect, but assessing it can be challenging. Herro et al. (2017) developed a model for evaluating teamwork in STEAM activities, focusing on peer assessment and rubrics to enhance reliability. Lin et al. (2015) found that digital tools can track communication patterns and involvement, providing a more objective view of group dynamics.

Despite these advancements, there are still challenges. Jensen et al. (2021) observed that educators struggle to identify individual contributions in group assignment, while Linga et al. (2025) raised concerns about the subjective nature of evaluating of teamwork. These findings highlight the need for improved and transparent assessment system.

2.2.3 Evaluating Problem-Solving Competencies

Problem-solving in STEAM education is traditionally assessed based on inquiry tasks and real-life

problems. Ilmiwan et al. (2019) demonstrated that authentic assessment also improves students' ability to perform science processes, while Amalina and Vidakovich (2022) emphasised the importance of assessing analytical reasoning over task completion. However, measuring the deeper aspects of problem-solving poses challenges. According to Han et al. (2024), there are difficulties in assessing metacognition, adaptability, and strategic thinking, which are essential elements of complex problem-solving in interdisciplinary settings.

2.2.4 Role of Rubrics in Integrated Competency Assessment

Rubrics are important for enhancing the validity and consistency of authentic assessment. They provide systematic guidelines for evaluating complex competencies and help reduce subjectivity in scoring (ElSayary, 2021a, 2021b; Care & Kim, 2017). In STEAM education, rubrics can be developed to assess multiple dimensions of learning such as creativity, collaboration, and problem-solving simultaneously, highlighting the use of rubrics in integrative competencies (Care & Kim, 2017).

However, the literature suggests that designing effective rubrics remains challenging. Without specific criteria and validation procedures, rubrics may lead to inconsistent or subjective evaluation (Care & Kim, 2017; Vlachopoulos & Makri, 2024). Furthermore, when creating rubrics aligned with interdisciplinary learning outcomes, it is essential to consider both disciplinary knowledge and interdisciplinary factors, adding complexity to the process.

2.2.5 Student Self-Assessment and Reflective Practices

Self-reflection and self-assessment are becoming increasingly important component of authentic assessment. These methods help students become more engaged in assessing their own learning processes, which in turn enhances their metacognitive abilities and overall comprehension (ElSayary, 2021a, 2021b; Kasimatis & Papageorgiou, 2020).

In STEM fields, reflective practice can involve keeping journals, creating portfolios, and engaging feedback loop cycles. These practices provide learners with opportunities to track their progress and make improvements throughout their learning journey (ElSayary, 2021a; Irma et al., 2023). Developing skills through such practices aligns with the overarching goal of authentic assessment as a continuous process driven by the learner. However, effective self-assessment should enable students to evaluate their work on a critically, which may require systematic guidance and clear standards (Irma et al., 2023).

Table 2. Authentic Assessment Approaches for Creativity, Collaboration, and Problem-Solving

Competency	Authentic Methods	Assessment	Example Practices	Key References
Creativity	Project-based tasks, design challenges, portfolios	design	Prototype design, idea journals, innovation projects	ElSayary (2021b); Hsu et al. (2023)
Collaboration	Peer assessment, teamwork rubrics, group performance evaluation	teamwork	Team design challenges, collaborative research tasks	Herro et al. (2017); Jensen et al. (2021)
Problem-Solving	Inquiry-based tasks, case studies, engineering design problems	case design	Real-world challenges, STEM investigative experiments	Ilmiwan et al. (2019); Amalina & Vidakovich (2022)

Source(s): Author's own work

2.3 Challenges in Implementing Authentic Assessment in STEAM Education

Although the rationale for using authentic assessment is based on a solid theoretical foundation, the literature has been clear in identifying several implementation issues that hinder the successful use of authentic assessment in STEAM classrooms. One of the most frequently reported barriers is teacher readiness and assessment literacy. An analysis of the literature on the development of authentic assessment tools, conducted by Marwa et al. (2024) revealed that most educators do not receive training on creating performance-based assignments and multidimensional rubrics. Similarly, Naufalin et al. (2023) and Baskaran and Abdullah (2020) observed that teachers lack the opportunity to conduct complex competency data analysis due to their limited professional development in assessment practices. These findings highlight the need for continuous teacher education and institutional guidance to effectively implement authentic assessment.

Time is a significant challenge in implementing authentic assessment. Vlachopoulos and Makri (2024) emphasized that authentic assessment requires extensive planning, observation, and personalized feedback, which can be overwhelming for teachers. In STEAM environments, monitoring student progress is difficult due to interdisciplinary and collaborative projects, making it a time-consuming task. Teachers often struggle to find a balance between the requirements of authentic assessment, covering the curriculum, and meeting the administrative demands.

Institutional and policy barriers are also crucial. Konyeme and Alordiah (2024) found that standardized testing remains the primary form of educational accountability, limiting teachers’ ability to implement new assessment methods. As a result, the authentic assessment may be seen as superficial or supplementary rather than integral to classroom practice.

Another significant problem is the difficulty in measuring collaborative and creative processes. Jensen et al. (2021) emphasized that isolating the role of individuals working in groups is challenging, leading to doubts about equity and consistency. Similarly, Linga et al. (2025) found that subjective perceptions of innovation and teamwork often result in varying scores. Additionally, Nada et al. (2025) added that classroom management aspects, particularly, achieving equity in participation among learners, pose challenges in implementing authentic assessment in a collaborative classroom learning setting.

All of these findings indicate that implementing authentic assessment in practice would necessitate significant systemic changes, including teacher training, policy adjustments, workload changes, and improved assessment instruments. Table 3 provides an overview of the key obstacles described in the literature regarding the implementation of authentic assessment in STEAM classrooms.

Table 3. Key Challenges in Implementing Authentic Assessment in STEAM Classrooms

Challenge	Description	Supporting Studies
Teacher assessment literacy	Teachers often lack training in designing performance-based tasks and rubrics	Marwa et al. (2024); Naufalin et al. (2023)
Time constraints	Authentic assessment requires continuous observation, feedback, and documentation	Vlachopoulos & Makri (2024)
Policy and institutional barriers	Standardized testing systems limit adoption of innovative assessments	Konyeme & Alordiah (2024)
Reliability and scoring consistency	Subjective evaluation of creativity and collaboration may reduce reliability	Linga et al. (2025); Jensen et al. (2021)
Infrastructure and technology issues	Digital assessment requires adequate tools and teacher training	Mahmood & Saleem (2024)

Source(s): Author’s own work

2.4 Research Gaps in Authentic Assessment in STEAM Education

Despite substantial developments, there are still significant research gaps apparent in the literature on authentic assessment in STEAM education. One of the most obvious gaps is the lack of comprehensive frameworks that can assess integrated competencies as a whole. Chen and Ding (2025) noted that existing assessment scales often treat creativity, collaboration, and problem-solving as separate constructs, which hinders their ability to reflect the dynamic nature of skills in real-life learning environments. Similarly, Thornhill-Miller et al. (2023) indicated that current assessment models do not prioritize the interconnectedness of 21st-century competencies.

Another notable gap is the limited research on STEAM-specific assessment. While there has been a significant amount of research on STEM education, there has been a lack of research on the interdisciplinary nature of arts in STEAM. As noted by Dubek et al. (2021), artistic creativity as an assessment component present specific evaluation challenges that have not been thoroughly examined. Furthermore, assessment of collaborative processes has not been adequately developed. Herro et al. (2017) have pointed out that current tools rely on teacher observation, introducing subjectivity and bias. Jensen et al. (2021) emphasized the need to create more efficient objective measurement tools that can accurately depict the dynamic interactions within a group.

This study aims to address these gaps by conducting an empirical phenomenological inquiry into the lived experiences of STEAM teachers regarding authentic assessment practices. The focus will be on how creativity, collaboration, and problem-solving are assessed in an integrated rather than fragmented manner.

3. Methodology

3.1 Methodological Orientation

This study is grounded in an interpretivist philosophical paradigm, which holds that reality is socially constructed and that meaning emerges through individual experience and interpretation (Creswell & Poth, 2018). Ontologically, the study adopts a relativist position, acknowledging that multiple, context-dependent realities exist among STEAM teachers regarding their assessment practices. Epistemologically, the study takes a subjectivist stance, recognizing that knowledge is co-constructed between the researcher and participants through dialogue and reflection (Bryman, 2016). This philosophical orientation aligns with the study's intent to explore the nuanced, lived experiences of educators rather than to generalize across populations.

3.2 Research Design

A qualitative phenomenological design was employed, following Moustakas's (1994) descriptive phenomenological approach. Phenomenology is appropriate when the goal is to understand the essential structures of a shared human experience. In this case, the focus is on teachers' lived experiences of integrating authentic assessment within STEAM classrooms. This design allows the researcher to set aside prior assumptions (*epoché*) and prioritize participants' own accounts as the primary source of meaning.

3.3 Population, Sample, and Sampling Technique

The target population consisted of practicing STEAM teachers at the secondary level. Purposive sampling was employed to recruit participants who had direct, hands-on experience with authentic assessment practices (Patton, 2015). A sample of six participants was chosen, in line with phenomenological conventions which recommend 5 to 25 participants ensure there is enough information (Creswell & Poth, 2018). Inclusion criteria stipulated a minimum of three years of STEAM teaching experience and a demonstrated familiarity with performance-based assessment methods.

3.4 Data Collection Tool

Data was collected through semi-structured, in-depth interviews, each lasting approximately 45 to 60 minutes. An interview protocol consisting of open-ended questions was structured around three main themes: current authentic assessment practices, challenges in implementation, and strategies for adaption. The protocol underwent review for content validity by subject-matter experts and was piloted before being fully implemented. Participants gave their consent for the interviews to be audio-recorded, and the recordings were transcribed verbatim.

3.5 Data Analysis

Data was analyzed using thematic analysis as outlined by Braun and Clarke (2006). This process involved reading and familiarizing oneself with the data, generating initial codes, searching for themes, reviewing and refining those themes, and finally defining and naming themes that captured meaningful patterns across participants' responses. Trustworthiness was ensured through member checking, providing thick descriptions, maintaining an audit trail, and engaging in reflexive bracketing as documented in a researcher journal (Lincoln & Guba, 1985).

3.6 Ethical Considerations

Ethical integrity was maintained throughout the study. Informed consent was obtained from all participants prior to data collection. Confidentiality was preserved through pseudonymization of participant identities and institutional affiliations. Participation was entirely voluntary, with the right to withdraw at any stage without consequence. Institutional ethical approval was secured before the commencement of fieldwork, and all data were stored securely in compliance with institutional data protection protocols.

4. Findings

In this section, the findings of the study based on the three research questions are discussed. The results of the interview conducted with six STEAM teachers in Sukkur, Sindh, provided an in-depth and contextually grounded account of real-life experiences of implementing authentic assessment. The thematic analysis revealed three overall themes, each with sub-themes as explained below.

4.1 Authentic Assessment Practices in STEAM Classrooms

The first theme explores the current practices of STEAM teachers based in Sukkur in relation to authentic assessment for evaluating creativity, teamwork, and problem-solving skills. Despite facing limitations in terms of finances and infrastructure in the region, the participants showed a strong interest in moving away from traditional paper-based tests and towards more value-driven forms of assessment. The educators described their practices as evolving gradually over time, through personal experimentation, collaboration with other professionals, and a growing awareness of the limitations of conventional tests in accurately assessing students' practical skills.

4.1.1 Use of Real-World and Contextually Meaningful Tasks

All participants reported using assessment tasks that linked learning to real-world or local situations. Teachers explained that they engaged students in tasks such as developing a water filtration system using low-cost materials, formulating waste management strategies in their local communities, and devising engineering solutions to infrastructure problems that often arise in Sukkur. Additionally, they conducted role plays, and storytelling based on social scenarios encountered in daily life. Participants appreciated the local relevance of these tasks as they felt purposeful during the learning process and believed the activities were related to the real world of the students.

"When teaching environmental science concepts, I ask students to suggest solutions for waste management

problems in their local community. In mathematics or engineering activities, students may design simple models related to home, school, or community issues." (Participant B)

Another participant connected real-world problem-solving directly to rubric-based assessment design. They observed that the indicators on rubric sheets were intentionally oriented towards demanding real-world problem requirements rather than theoretical recall. While the participants appreciated this approach, they also recognized that systematic evaluation posed a challenge, especially when dealing with interdisciplinary and complex activities. This was particularly difficult without clearly defined evaluation criteria that could assess various aspects of student performance simultaneously.

4.1.2 Use of Rubrics as Assessment Tools

The majority of participants reported using rubrics as their primary structured tool for assessing students' performance across three competencies. The complexity and uniformity of these rubrics varied among participants. Some created detailed rubrics based on online sources and experience, while others used simplified versions obtained from colleagues. One participant described using rubrics designed to address all indicators of different competencies:

"Yes, I used rubrics tool for assessing these competencies. Rubrics were designed carefully to cover all the indicators to assess these competencies." (Participant F)

Another participant mentioned sharing rubrics with students in advance to promote transparency:

"I create a simple rubric with three or four criteria, such as creativity, teamwork, and clarity of explanation. I share it with students before the task so they know what is expected." (Participant E)

Despite these efforts, participants acknowledged that their rubrics did not fully encompass the interdependence of competencies, treating creativity, collaboration and problem-solving as separate aspects of performance.

4.1.3 Performance-Based and Collaborative Assessment Tasks

The diversity of performance-based tasks identified by participants to assess student competencies in an integrated way was quite broad. These tasks included group work, science experiments, poster making, model building, peer teaching, role plays, and design challenge based on the community. One participant shared their experience with a recent STEAM lesson involving a robotics activity:

"Recently I conducted a STEAM lesson on an alligator robot and used rubrics to evaluate the students' performance." (Participant C)

Participants also mentioned the use of formative assessment strategies such as questioning, peer reviews, classroom observation and self-evaluation checklists. These strategies were particularly helpful for students with weaker foundational skills who required more support in their participation.

4.2 Challenges in Implementing Authentic Assessment

The second theme explores the challenges that STEAM teachers in Sukkur face when implementing authentic assessment. Participants have identified a variety of interconnected issues stemming from structural, institutional, and contextual factors. These complex issues present significant barriers to establishing an environment conducive to sustained authentic assessment.

4.2.1 Curriculum Overload and Coverage Pressure

The most common challenge among all participants was the conflict between implementing authentic assessment and meeting the requirements of course content coverage. Teachers expressed that they often struggle to balance the demands of the prescribed syllabus with the time needed to develop and carry out a meaningful assessment task. The curriculum primarily focused on exams, so authentic assessment was viewed as supplementary rather than integral to classroom practice.

4.2.2 Resource Constraints

The lack or inadequacy of physical and technological resources was consistently highlighted by the participants as a significant barrier to authentic assessment. Many schools lacked basic laboratory equipment, reliable internet access, functioning computers, and digital resources. It was common for teachers to improvise using resources available in the local area or purchased out of pocket to compensate for balance institutional shortcomings. One teacher expressed the frustration, stating, *"We do not have a proper science lab. Sometimes I have to bring materials from homes. How can I expect students to complete an engineering design task when we do not even have the necessary supplies?"* (Participant A)

Another participant also confirmed that digital tools were not currently being used in assessment practices, but there were intentions to utilize them in the future. This indicates an understanding of their potential usefulness and the challenges involved in implementing them in practice.

4.2.3 Lack of Knowledge, Skills, and Training

Many participants admitted they felt unprepared to plan and develop authentic assessment and put them into practice with the richness and uniformity they require. They said that their original teacher education courses had given them minimal or no exposure to performance-based evaluation, rubric design and frameworks, or competency-based assessment. Teachers had to develop these skills mostly on their own because there was no formal system to learn and become involved in professional development in that regard (Done May 23).

4.2.4 Lack of Institutional Support

The respondents have shared that there was little support and appreciation of their efforts to be innovative in assessment practices by the school administration. School leadership is characterized as mainly concerned about the outcome of board examinations, with little opportunity to appreciate process-based or competency-focused efforts. One teacher observed:

"The principal only asks about results. If students pass the board exam, everyone is happy. Nobody asks how they learned or what skills they developed." (Participant D)

A number of the respondents remarked that simple institutional assistance for the project such as special time to work on the project or availability of basic materials, could greatly enhance their ability to establish authentic assessment more frequently and with greater self-assurance.

4.2.5 Workload and Time Management

In addition to the pressure of covering content, the respondents highlighted other significant work pressures that made it difficult to consistently use authentic assessment. Teachers were required to teach multiple classes each day, manage large classes of up to forty or fifty students, complete administrative tasks, and prepare students for additional exams. This left them with little time to plan and execute complex assessment activities. The large class sizes and heavy administrative workload were particularly challenging, as providing individualized observation and feedback on a large scale was logistically very difficult.

4.3 Strategies for Addressing Implementation Challenges

Participants demonstrated significant agency, creativity and resilience in identifying solutions to maintain authentic assessment practices, despite the challenging conditions in their educational settings. Their practical strategies were primarily based on their own initiative and tailored to the realities of teaching in Sukkur.

4.3.1 Careful Integration of Authentic Assessment into Curriculum

Some participants addressed the conflict between authentic assessment and coverage of the curriculum by integrating assessment tasks into normal teaching activities rather than treating them as separate activities. Teachers were able to meet content requirements and assess competencies simultaneously by linking project-based tasks to topics in the syllabus. One teacher elaborated:

"I design my projects around the topics in the syllabus. For example, when teaching ecosystems, I ask students to design a solution for the environmental problems in Sukkur's Indus riverbank. It covers the content while evaluating their creativity and problem-solving skills." (Participant E)

Participants also found success in breaking down larger projects into smaller tasks, allowing for assessment to be spread out over multiple lessons to accommodate limited timetables.

4.3.2 Development and Refinement of Rubrics

The participants discussed a continuous, progressive process of creating and updating their assessment rubrics in consecutive academic years. One respondent explained that they established a rubric pattern with designed structure to consistently cover the three competencies. Another respondent described how rubrics were developed through peer consultations in an informal manner across departments, creating small communities of practice within their schools:

"Every year I enhance my rubric based on what worked and what did not. I also share it with my colleague who teaches science and we discuss whether the criteria make sense." (Participant A)

4.3.3 Use of Digital Tools and Platforms

Although the level of internet connectivity is low and irregular, a few participants reported how they creatively used the tools they to facilitate authentic assessment. Tools such as WhatsApp groups were used to share student work and engage in peer assessment, Google Forms for self-assessment checklists, Canva for designing presentations, Padlet for sharing ideas with peers, and YouTube for accessing instructional ideas and example projects.

One participant mentioned that they had not fully adopted digital tools into their assessment practice but were considering doing so. This could indicate of their awareness of the opportunities digital tools offer in the process of documentation and providing personal feedback.

4.3.4 Self-Directed Professional Development

Since no formal training was provided on authentic assessment, the participants explained that they invested their own time and resources to improve their knowledge and skills in assessment. This included watching educational materials on YouTube, enrolling in free courses on sites like Coursera and DigiSkills, participating in teacher communities on Facebook, and reading materials on frameworks such as ATC21S on their own. Respondents emphasized the impact of self-directed learning on 21st-century skills models on their teaching practice, noting that self-directed learning can be a valuable resource in a low-resource environment as an alternative to formal professional development.

4.3.5 Seeking Institutional Support and Peer Collaboration

Several participants discussed the proactive methods they used to garner support for the implementation of authentic assessment in their institutions. These methods included creating proposals for school leadership, introducing ideas for assessment redesign during staff meetings, and collaborating with fellow educators to develop activities together. Participants noted the positive impact of training provided by external organizations. One participant shared their reflection on the training they received:

The organization's training on project-based learning (PBL) and authentic assessment has enhanced my approach to authentic assessment." (Participant C)

5. Discussion

The results of this paper support the overall argument in the literature that authentic assessment offers a more significant and reliable method for assessing integrated 21st century competencies in STEAM classes. Teachers were found to be implementing real life design challenges, project-based learning tasks, collaborative inquiries and teacher created rubrics to evaluate the creativity, collaboration, and problem-solving skills of students. The findings align with previous studies indicating that assessment should reflect how students apply and transfer information rather than just memorizing facts (Pellegrino, 2016). The findings also confirm the conclusions of Vlachopoulos and Makri (2024), who revealed that authentic assessment fosters the development and testing of complex competences in significant situations.

Another important implication of the research is that it empirically shows how teachers implement the concept of authentic assessment in a resource-limited environment. Participants create their own rubrics, tailor their tasks to meet the realities of the local area, and refine their practices through experimentation and reflection. This suggests that authentic assessment is not a rigid methodology but a context-sensitive instructional approach that is influenced by the judgment of teachers and the local context. This finding is supported by other studies such as Care and Kim (2017), who argue that creativity, collaboration, and problem-solving should be measured as a set of interdependent competencies rather than as distinct entities.

The results also highlighted the importance of using real-life and locally relevant contexts in assessment. Activities such as waste management, water purification, and community problem-solving helped students develop integrated competences in a way that is not achievable through traditional written tests. This supports research showing that hands-on, discovery-based activities enhance cognitive learning and promote overall engagement in STEAM education (ElSayary, 2021a; Tan and Kidman, 2021).

The research shows a significant disconnect between the pedagogical needs of teachers and the actual circumstances in their institutions. The use of authentic assessment is hindered by curriculum overload, the needs to prepare students for board exams, heavy workloads, inadequate resources, lack of professional development, and apathetic management. These findings align with previous research highlighting similar barriers to implementation (Marwa et al., 2024; Naufalin et al., 2023; Vlachopoulos and Makri, 2024). They also suggest that comprehensive assessment reform is unattainable as long as accountability measures are tied to standardized exam results (Konyeme & Alordiah, 2024).

Theoretical issues involved in the design of rubrics are challenging. Despite their popularity, teachers have noted that rubrics do not allow them to capture the intangible and interconnected nature of creativity, collaboration and problem-solving. This reflects a broader conflict in the literature: competencies appear to exist on a continuum in practice, while scoring tools tend to place them in discrete categories (Care & Kim, 2017; Thornhill-Miller et al., 2023). The results suggest that the use of technical instruments alone is not a definitive measure of valid assessment without being supported by solid conceptual knowledge.

Participants' adaptive strategies demonstrate a high level of professional agency. Teachers implemented projects on syllabus topics, utilized user-friendly online tools such as WhatsApp, Google Forms and Canva, engaged in professional learning independently and with colleagues to improve their practice. These adaptive strategies show that meaningful innovation can still be achieved even with limited resources. However, the reliance on individual initiative raises concerns about sustainability and equity, as implementation is largely dependent on teachers' motivation rather than systematic support.

The findings generally support the idea that authentic assessment has immense potential in assessing integrated competencies in STEAM education. However, its success relies on the alignment of pedagogy, teacher knowledge, institutional support, and policy systems.

6. Recommendations

Based on the findings, several recommendations are proposed. Firstly, teacher education courses should include clearly defined training in authentic assessment. This training should cover how to design

interdisciplinary performance tasks, develop rubrics and evaluate integrated skills such as creativity, collaboration, and problem-solving. Additionally, structured professional development and dedicated time in schools should be provided to enable teachers to collaboratively develop assessment tools and improve their practices together.

Secondly, curriculum officials should reduce syllabus load and provide more flexibility through project-based and inquiry-based education. It is difficult to improvement authentic assessment when educators are under pressure to cover a large amount of content for high-stakes assessments. School leaders can support this by allocating time for project work, providing resources and promoting authentic evaluation as a core teaching practice.

Lastly, policymaking should be reformed to focus on competency improvement rather than solely passing fact-based examinations. Schools should utilize online tools such Google Forms, WhatsApp, and Canva to assist with documentation, peer feedback, student reflection, and formative evaluation.

7. Implications

This research study has significant theoretical, practical and policy implications. The results reinforce the argument that creativity, collaboration and problem solving are competencies that are interdependent and developed as a result of authentic assessment, not through isolated testing. The research endorses the approach of combined models of evaluation based on process, context, and the transfer of learning.

In practical terms, teacher assessment literacy is vital as highlighted in the study. To design valid performance tasks, develop effective rubrics, and discern multi-faceted evidence of student learning, teachers need theory and practice to apply. The results also indicate that meaningful assessment innovation can be achieved in low-resource conditions as teachers can adjust to local realities and available technologies for learning.

Regarding school leadership, the research indicates that conditions facilitating authentic assessment must be created. These include shared planning frameworks, moderate workloads, commitment to project-based and inquiry-based teaching approaches, and appreciate innovative instructional practices. Support in leadership appears to be a key element in the continuation of assessment reform.

At the policy level, the results indicate that competency-based education will not be achieved if external examinations focus primarily on memorizing facts. Therefore, policy frameworks should ensure that the integration of curriculum, pedagogy, and assessment expectations.

This study contributes to the contextual evidence from Pakistan where no sufficient empirical work has been done on authentic assessment in STEAM education. It provides a framework for future research on culturally responsive and locally viable methods for measuring the 21st-century competencies.

8. Conclusion

This paper focused on the lived experiences of STEAM teachers in Sukkur, Sindh, regarding the application of authentic assessment to evaluate creativity, collaboration and problem solving as integrated competencies of the 21st-century. The results revealed that teachers are using real-life tasks, group projects, and teacher-created rubrics to assess the student learning in more meaningful ways than traditional exams.

However, there are still numerous challenges in implementation due to curriculum overload, pressures from board examinations, lack of resources, inadequate training, insufficient institutional support, and heavy workloads. Despite these constraints, teachers demonstrated a high level of professional agency by integrating projects into current syllabus areas, developing rubrics, utilizing digital tools, engaging in self-directed learning, and collaborating with the colleagues.

The study concludes that authentic assessment has significant potential for capturing the complexity of integrated competencies in STEAM education. However, its effectiveness and sustainability in the long term

require systemic alignment between teacher preparation policies, school leadership, curriculum flexibility, and the national assessment system.

This study contributes to the growing body of work on authentic assessment by providing empirical evidence from Pakistan and highlighting the necessary steps to transform innovative classroom practices into long-term educational reform.

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