The Use of Scenario-based Assessment in Assessing Students' Collaborative Problem-solving Skills

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Abstract

Scenario-based assessment (SBA) has emerged as an effective method for evaluating students' collaborative problem-solving (CPS) skills in educational settings. This approach simulates real-world challenges, requiring students to work together to solve complex, context-rich problems. By embedding tasks that mirror authentic scenarios, SBA allows educators to assess not only individual knowledge but also the dynamic interplay of communication, cooperation, and critical thinking within collaborative groups. On account of merits that SBA has brought to assessment and measurement, more research should be conducted on how to apply SBA effectively in assessing students' CPS skills. This study reviews the theoretical foundations, application methods, and benefits of SBA in measuring CPS, highlighting its potential to prepare students for the collaborative nature of modern workplaces.

Keywords: 21st century skills, assessment, measurement, collaborative problem-solving skills

1. Introduction

In the 21st century, collaborative problem-solving (CPS) skills have emerged as essential competencies for success in both educational and professional contexts. As global challenges become increasingly complex, the ability to work effectively with others to solve problems is no longer optional; it is a critical requirement. Employers across industries emphasize the importance of CPS skills, noting that graduates must be equipped not only with technical knowledge but also with the ability to collaborate, communicate, and innovate. As Griffin and Care (2014) argued, CPS skills are crucial for navigating the rapidly changing demands of the modern workplace, where teamwork and collective problem-solving are key drivers of success.

The importance of assessing CPS skills has gained significant attention from educators and policymakers, who recognize the need to prepare students for real-world challenges. Traditional assessment methods, such as standardized tests, often fail to capture the intricacies of CPS, which involve not only individual problem-solving abilities but also the capacity to engage in collaborative processes. These processes are integral to addressing the pressing issues of the 21st century, many of which require collaborative efforts to find effective solutions (Graesser et al., 2018). As such, there is a growing need for assessment tools that can accurately measure students' CPS skills, reflecting both their cognitive abilities and their collaborative processes.

Given the limitations of traditional assessment methods, alternative approaches such as Scenario-Based Assessment (SBA) have emerged as more effective means of evaluating CPS skills. SBA involves placing students in simulated real-world scenarios where they must collaborate to solve complex problems. This approach not only assesses the outcomes of the problem-solving process but also examines how students work together, providing a more comprehensive evaluation of their CPS abilities. Unlike traditional tests, which often isolate problem-solving tasks, SBAs offer a dynamic and authentic measure of students' skills, reflecting the collaborative efforts required in real-world contexts (OECD, 2017). This method aligns with the demands of the modern workforce, where the ability to collaborate effectively is often as important as individual expertise.

As the importance of CPS skills continues to grow, so too does the need for assessment tools that can capture the complexity of these skills in real-world contexts (OECD, 2017; Griffin & Care, 2014). The use of SBA represents a promising alternative to traditional assessment methods, offering a way to evaluate not just what students know, but how they collaborate and problem-solve in practice. This research aims to contribute to the development of such tools, ensuring that educational assessments keep pace with the evolving demands of the 21st century.

2. LITERATURE REVIEW

2.1. Definition of collaborative problem-solving skills

Collaborative problem-solving (CPS) is a crucial skill in the 21st century, encompassing both cognitive and social components that enable individuals to work together effectively in solving complex problems. As global challenges grow in complexity, the need for collaborative efforts becomes increasingly evident, making CPS a vital competency in both educational and professional contexts (OECD, 2017). CPS integrates the cognitive processes involved in problem-solving with the social interactions necessary for effective collaboration, creating a dynamic interplay between individual and collective efforts.

Collaboration in CPS is defined as the process by which two or more individuals work together towards a common goal, especially when the task is too complex for one person to handle alone (Hesse et al., 2015; Griffin & Care, 2014). Key components of collaboration include communication, which is essential for exchanging information and ensuring shared understanding, and cooperation, where group members contribute to planning and problem analysis. Effective collaboration leverages the diverse strengths of all participants, leading to more innovative and robust solutions (Griffin & Care, 2014).

Problem-solving in CPS involves the cognitive processes required to bridge the gap between a current state and a desired goal state. This includes identifying and defining the problem, developing strategies to address it, and applying self-regulation to monitor progress (OECD, 2017). In a collaborative setting, problem-solving becomes a shared activity where cognitive tasks are distributed among group members, enhancing the effectiveness and creativity of the solutions generated (Hesse et al., 2015).

In the context of this research, CPS is defined as the individual's capacity to effectively cooperate with others by sharing understanding and expertise, thereby identifying problems and striving to find optimal solutions towards a common goal. This definition aligns with the broader understanding of CPS as a joint activity that requires both cognitive and social competencies, underscoring its importance as a key skill for success in the 21st century (OECD, 2017; Hesse et al., 2015; Griffin & Care, 2014).

2.2. Scenario-based assessment (SBA)

Scenario-based assessment (SBA) has become a prominent method for evaluating complex skills like collaborative problem-solving (CPS). Unlike traditional assessments that often focus on isolated tasks and individual performance, SBA presents students with real-world scenarios that require them to apply a combination of skills in a dynamic, contextually rich environment. This approach enables a more comprehensive evaluation of CPS's cognitive and social dimensions, making it particularly relevant in today's educational landscape, where practical, real-world skills are increasingly emphasized (Shute & Ventura, 2013; Clarke-Midura & Dede, 2010). SBA involves placing students in simulated scenarios that closely mirror real-life challenges. These scenarios reflect the complexities and uncertainties of actual situations, requiring students to engage in problem-solving processes involving collaboration, communication, and critical thinking (Hao et al., 2017; Ifenthaler, 2012). Through SBA, educators can observe how students approach problems, interact with peers, and adapt strategies, providing a richer and more nuanced understanding of their CPS skills (Liu et al., 2016).

One of the significant advantages of SBA is its ability to assess both the process and the outcome of problem-solving. Traditional assessments often focus on the final product, such as the correct answer to a problem, without considering the steps taken to reach that solution. In contrast, SBA allows educators to observe how students work together to solve problems, including communicating, negotiating, and adapting to changing conditions. This process-oriented approach captures the intricacies of collaboration, providing insights into the quality of interactions and the effectiveness of teamwork (Hao et al., 2017; Clarke-Midura & Dede, 2010). Moreover, SBA aligns well with the demands of the modern workforce, where employees are often required to work in teams, navigate complex problems, and adapt to changing circumstances. SBA replicates these real-world demands by requiring students to collaborate in solving problems, enhancing the assessment's relevance and better preparing students for future challenges (Mislevy & Riconscente, 2006). Furthermore, SBA offers flexibility in assessment design, allowing scenarios to be tailored to different educational contexts and learning objectives. This adaptability ensures that assessments are culturally and pedagogically appropriate and address students' diverse needs. Educators can design scenarios that reflect specific challenges in various fields, making SBA a versatile tool for assessing CPS across different domains (Hesse et al., 2015; Shute & Ventura, 2013).

Despite its advantages, implementing SBA poses challenges. Designing scenarios that accurately reflect real-world problems while manageable within an educational setting requires

careful planning and resources. Additionally, assessing students' performance in these scenarios involves analyzing both qualitative and quantitative data, which can be complex and time-consuming. Nevertheless, the depth and authenticity that SBA brings to the assessment of CPS make it a valuable tool in modern education (Mislevy & Riconscente, 2006).

2.3. The use of scenario-based assessment in assessing collaborative problem-solving skills

The use of Scenario-Based Assessment (SBA) to evaluate collaborative problem-solving (CPS) skills has evolved significantly over the years. This section reviews key studies chronologically to illustrate the development and effectiveness of SBA in this area.

The early exploration of SBA as a tool for assessing CPS began in the 2000s. Clarke-Midura and Dede (2010) were among the pioneers, examining how SBA could be used to measure 21st-century skills, including CPS. Their research highlighted the potential of SBA to assess not just the outcomes but also the processes involved in CPS. By situating students in realistic scenarios, their study demonstrated how SBA could capture the nuances of student interactions, such as communication, negotiation, and role distribution, which are critical to effective collaboration. This early work laid the groundwork for subsequent studies by establishing the importance of assessing both the cognitive and social aspects of CPS.

Building on these foundations, Hao et al. (2017) conducted a study that further solidified SBA's role in assessing CPS. Their research focused on developing a CPS assessment tool using scenario-based tasks. This study emphasized the importance of understanding the dynamics of group interactions and the roles that students play within these groups. The findings confirmed that SBA could provide detailed insights into how students collaborate, making it possible to evaluate not just the final solution but also the quality of the collaborative process itself. This study was pivotal in demonstrating SBA's ability to uncover the underlying processes that contribute to successful CPS.

Ifenthaler (2012) explored the application of SBA in higher education, focusing on its effectiveness in assessing students' abilities to apply theoretical knowledge in practical, real-world situations. This study was particularly significant because it addressed the challenge of bridging the gap between theoretical knowledge and practical application—a key issue in higher education. Ifenthaler (2012) found that SBA was highly effective in evaluating CPS skills, as it provided a more authentic and comprehensive assessment of students' abilities than traditional methods. His

work underscored the versatility of SBA in assessing CPS across different educational levels and contexts.

The relevance of SBA in digital environments was further explored by Liu et al. (2016), who examined how SBA could be adapted for use in online and blended learning settings. Their study highlighted the flexibility of SBA, showing that it could be effectively used to assess CPS in a variety of educational contexts. Liu et al. found that SBA was particularly useful in digital environments, where students often engage in collaborative tasks using technology-enhanced tools. This study extended the application of SBA to the growing field of digital education, demonstrating its adaptability and relevance in contemporary educational settings.

More recently, Scoular and Otieno (2024) investigated the use of SBA in the ALiVE project in East Africa. This study is notable for its focus on culturally relevant scenarios, demonstrating that SBA can be tailored to assess CPS in diverse cultural contexts. The research found that SBA was effective not only in assessing CPS skills but also in promoting inclusivity and cultural relevance in assessments. This study highlights the global applicability of SBA, showing that it can be adapted to meet the needs of students in various cultural and educational environments.

Throughout the development of SBA, these studies have collectively contributed to our understanding of its effectiveness in assessing CPS skills. From its early exploration to its application in diverse and digital environments, SBA has proven to be a robust and flexible tool that captures the complexities of collaborative problem-solving in a way that traditional assessments cannot.

3. METHODOLOGY

3.1. The development of the assessment tool

An objective of this study was to address the first research question: "What should be done to construct a scenario-based test to assess students' CPS?" To develop this assessment tool, a multi-step process was undertaken. First, a comprehensive literature review was conducted to identify the key components of collaborative problem-solving (CPS) that are essential for evaluation. This review guided the design of scenario-based tasks that effectively measure these components, including communication, collaboration, problem analysis, and solution implementation. The scenarios were developed to reflect real-world problems that students might encounter, ensuring that the assessment tool is educationally relevant and practical in measuring CPS. Expert consultations were conducted to validate the content of the scenarios and ensure they adequately covered the

dimensions of CPS. The scenarios were then piloted with a small group of students to identify any clarity, difficulty, or relevance issues.

3.2. Data collection and analysis

The SBA tool served as the primary data collection instrument for this study. It consisted of scenarios designed to simulate real-world collaborative problem-solving situations. Each scenario required students to work with imaginative characters to solve a complex problem by choosing one out of four given options, with their interactions and problem-solving processes being the primary focus of assessment. A particular score was given to students based on their choice of response to each question. The assessment was designed to measure the final solution and the process, including how students communicate, share information, make decisions, and resolve conflicts.

Item Response Theory (IRT), specifically the Partial Credit Model (PCM), was employed to analyze the test data further. IRT provides a sophisticated method of evaluating each test item's difficulty and discrimination parameters, allowing for a more detailed understanding of how well each item functions in assessing student CPS skills. The use of IRT enables the differentiation of student abilities based on their responses to complex, multi-step problems, providing insights into their cognitive and collaborative capacities.

The data were processed using the ConQuest software specifically designed for IRT analysis. This allowed for the detailed modeling of student performance on the SBA, evaluating the fit of the data to the IRT model and providing estimates of student ability independent of the particular sample of items used. The analysis ensures that the assessment tool is reliable and valid, providing accurate and meaningful measures of student CPS skills across different contexts and populations.
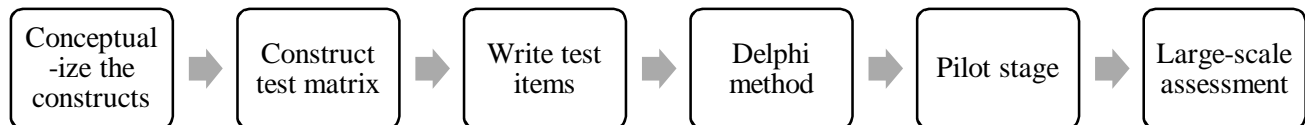
4. FINDINGS AND DISCUSSION

4.1. The construction of test matrix

The multiple-choice situational test to assess CPS ability of university students is built based on a 6-step process. The test aims to assess CPS of Vietnam National University (VNU) students through specific situations, including 4 component competencies and 15 assessment criteria, based on the theoretical framework of OECD (2017). In particular, the situations and questions are designed to suit the practical tasks that students often encounter, ensuring applicability and closeness to the requirements for assessing students' competencies during the learning process. The

test is designed to standardize students' CPS competencies, based on a theoretical framework of 4 component competencies and 15 criteria. The content of the questions is based on OECD (2017)'s competency assessment tools, adjusted to suit the context and practical tasks that VNU students may encounter. The distribution of criteria in the test is carefully considered to ensure comprehensiveness and uniformity.

Figure 1: The process of constructing SBA tool to assess CPS

Conceptual-ize the constructs → Construct test matrix → Write test items → Delphi method → Pilot stage → Large-scale assessment

The test matrix is built based on the component competency ratios in the OECD (2017)'s theoretical framework and tests. The proportions of the component competencies are distributed as follows: Exploring and understanding (~40%), Expressing and speaking, Planning and implementing (~30%), Monitoring and reflecting (~30%). The test consists of 35 multiple-choice questions, with an estimated completion time of 45 minutes, designed to comprehensively assess the stages of the collaborative problem-solving process.

4.2. The creation of questions based on the matrix

Based on the test matrix, the multiple-choice test is compiled with 35 questions, evenly distributed between the component competencies and assessment criteria. The estimated completion time of the test is 45 minutes. Each question in the test represents a situation that requires students to cooperate with fictional characters to solve a given problem.

The test scenarios are constructed according to a collaborative problem-solving sequence, consisting of four parts: (1) Identifying and agreeing on a common problem to be solved, (2) Sharing information and experiences to jointly identify the problem and its solution, (3) Collaboratively planning and implementing the problem, and (4) Evaluating the effectiveness of the solution and the collaborative process.

The first scenario in the test is based on the Xandar scenario task (OECD, 2015), in which students have to cooperate with their peers to answer questions about Vietnam National University. This scenario requires students to discuss and make joint decisions to solve the assigned problem, thereby assessing their collaborative and problem-solving skills.

4.3. The application of Delphi method in test construction

After the completion of the construction of the matrix and questions for the test to assess students' CPS competence, including all criteria and number of questions, this assessment tool was sent to experts for comments before being further edited and tested on a small scale. Delphi method was conducted through 2 steps with the same group of experts consisting of 10 people, including 2 lecturers at the University of Languages & International Studies related to language and translation, 2 experts in testing and assessment, and 6 lecturers currently teaching students at the universities participating in this study at VNU. After experts gave feedback and comments, the test matrix and questions were adjusted in order to improve the quality as well as the construct and face validity of the questions before the pilot stage.

4.4. Pilot and post-pilot stage

After the modification, the test was tested on two classes of VNU students, one class of first-year students from the Faculty of English Language Teacher Education, University of Languages & International Studies and one class of first-year students from the Faculty of Electronics and Telecommunications, University of Engineering and Technology.

After conducting a pilot test of the situational test to assess students' collaborative problem-solving abilities, the test questions were reviewed and adjusted based on feedback and results obtained from the pilot. The adjustment process included revising the content of unclear or misleading questions, ensuring that they accurately reflected real-life situations that students might encounter during their studies and work. In addition, questions that were too high or too low in difficulty were also adjusted to match the general level of students, ensuring balance and fairness in assessing abilities.

In brief, after the pilot stage, the student assessment results were collected and the data were cleaned to prepare for the analysis process. The analysis results showed that the test had good reliability and validity, suitable for use in assessing the CPS competency of university students. Then, the test was employed for a large-scale assessment with the participation of 1,252 students coming from different schools and universities within VNU.

4.5. The analysis of test results

The results of the large-scale test with the participation of 1,252 students showed that the majority of students self-assessed at the level of fair and high competence, with 82,19% of students

possessing medium level of CPS competence and 17.49% at the high level of CPS competence. Only 0.32% of students were estimated to have the lowest level of competence. These results show that the test is not only capable of accurately assessing students' competence but also has high applicability in assessing the CPS skills of university students.

Table 1: The results of the large-scale test

Number of students	Level of CPS competence	Percentage
4	1	0,32%
90	2	7,19%
939	3	75,00%
219	4	17,49%

CONCLUSION

In conclusion, SBA can be seen as a powerful tool for assessing students' CPS skills, which are critical for students' success in academic and real-world environments. Unlike traditional assessments that often focus on individual performance, SBA emphasizes the collective process through which groups of students engage with complex, real-world problems. These scenarios typically mirror situations encountered in professional or societal contexts, demanding students to collaborate, negotiate roles, make decisions, and solve problems together.

The key advantage of SBA lies in its ability to capture the dynamic nature of group interactions. It allows educators to evaluate not only the final outcomes of a group's work but also the processes that lead to those outcomes. Through SBA, students' communication skills, ability to negotiate roles, manage conflict, and integrate diverse perspectives are assessed. These are essential components of CPS, which involve both cognitive and social competencies. The assessment is often designed to provide a comprehensive picture of how individuals contribute to the group's overall problem-solving efforts, focusing on factors such as leadership, cooperation, and adaptability.

Moreover, SBA aligns well with the increasing emphasis on 21st-century skills in education, where collaborative problem-solving is seen as an essential competency for future success. By engaging students in real-world scenarios that require collaboration, SBA not only measures their current CPS abilities but also helps foster the development of these skills in a practical context.

In order to construct SBA tools to assess students' CPS skills, a 6-step process is recommended to be use as the procedure to create and conduct the test. These 6 steps include (1)

conceptualize the constructs of the competence, (2) construct the test matrix, (3) write test items, (4) asking for experts' opinion through Delphi method, (5) pilot the tool after modifying the questions, and (5) conduct large-scale assessment. In order to assess students' CPS skills, a new framework is also proposed, including 4 component competencies and 15 assessment criteria, based on the theoretical framework of OECD (2017). However, the contents of the questions should be modified or adapted to make them suitable for the new contexts and practical tasks that students in other universities may encounter.

However, implementing SBA comes with challenges. Designing meaningful, authentic scenarios that are both engaging and feasible for assessment purposes requires significant effort. Additionally, ensuring fairness in evaluating group processes, where individual contributions may vary, necessitates clear and transparent rubrics. Despite these challenges, SBA offers a robust framework for assessing and nurturing collaborative problem-solving skills, preparing students for collaborative work environments.

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