

# **ADVANCING COMPETENCY ASSESSMENT: INTEGRATING AUTHENTIC ASSESSMENT INTO COMPUTER-BASED ASSESSMENT FOR SEAFARERS**

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## **Keywords**

Authentic assessment, Assessment of competence, Computer-based assessments

## **Abstract**

The intricate landscape of assessing seafarers' competencies demands a comprehensive approach that ensures they possess the necessary skills to handle safety-critical duties, given the immense responsibility—people's lives, marine ecosystems, and properties valued in millions—entrusted to them. While Competency-Based Assessment offers consistent and objective evaluations through computer-based assessment, it faces limitations in assessing higher cognitive skills and meeting the Standards of Training, Certification, and Watchkeeping (STCW) criteria. This research explores the potential of integrating authentic assessment with computer-based assessment to address these limitations. Through a systematic literature review, the study highlights the strengths of authentic assessment, such as its grounding in real-life scenarios and learner-centered methodologies. These characteristics can be leveraged to align computer-based assessment questions and tasks with STCW requirements. Moreover, authentic assessments empower learners through contextualized evaluations, bridging the gap between skill sets and workplace applications. Integrating authentic assessment enhances the quality of computer-based assessment questions and tasks, providing a more rigorous evaluation of seafarers' competencies. While challenges in implementation need to be addressed, the potential synergy between authentic assessment and computer-based assessment presents a promising approach. This study proposes an enhanced assessment methodology that combines the strengths of computer-based assessment and authentic assessment, navigating the complexities of assessing seafarers' competencies while addressing the inherent challenges in competence-based assessment. This integrated approach holds promise for ensuring that seafarers possess the necessary skills to fulfill their safety-critical responsibilities.

## **1 INTRODUCTION**

Navigating the vast oceans requires exceptional competence. Seafarers are the lifeblood of maritime trade and hold immense responsibility for the safe passage of vessels and cargo, as well as the delicate ecosystems and lives entrusted to their care. To ensure this vital competence, international regulations play a crucial role. The International Maritime Organization (IMO) sets minimum standards for training and certification through the Standards of Training, Certification, and Watchkeeping (STCW) convention. This framework outlines the essential skills and knowledge seafarers must possess, depending on their onboard roles.

However, the path to achieving these standards can vary across nations. While the STCW provides a foundation, member states have flexibility in interpreting and implementing the convention within their jurisdictions. This leads to diverse maritime education and training systems, with different career paths, training styles, and approaches to assessing competence. Traditionally, competence assessments rely on methods like written exams, simulations, and onboard experience. Each approach has its merits, but some argue they leave gaps. Pen-and-paper tests might measure theoretical knowledge, while simulations can assess technical skills. However, these methods may fall short in evaluating crucial non-cognitive abilities like teamwork, communication, and problem-solving – essential qualities for effective seamanship.

This calls for a more holistic approach. Authentic assessments emerge as a promising solution. By simulating real-world scenarios and tasks relevant to seafaring roles, they offer a more comprehensive evaluation of a seafarer's readiness. Imagine trainees collaborating to navigate a simulated storm, demonstrating not just technical skills but also effective communication and decision-making under pressure. This paper delves into the limitations of current assessment methods and explores the potential of authentic assessments. It proposes strategies for integrating these innovative methods into existing frameworks, while upholding established standards. Furthermore, it examines the potential benefits of this approach, from enhanced safety at sea to fostering a more skilled and well-rounded seafaring workforce. By examining the strengths and weaknesses of current practices and advocating for a more comprehensive approach, this study aims to contribute to a safer and more competent maritime future.

## **2 COMPETENCE-BASED ASSESSMENT**

The assessment of competence has changed over time, just like the concept of competence itself. Hager et al., (1994) highlighted the early challenges of competence-based assessment due to its novelty. Wolf (1995) suggests a shift from "competence-based education" to "competence-based assessment" for implementation clarity. Fletcher (2000) outlines key features like setting criteria, collecting evidence, and quality assurance. Muñoz & Araya (2017) present a balanced view, acknowledging both opportunities and challenges in education. Bergsmann et al., (2015) identify limitations of traditional evaluation instruments in capturing broader competencies. Herppich et al. (2018) define competencies as context-specific and learnable, emphasizing the importance of situational relevance. Holmes et al. (2021) highlight ongoing tensions around implementing competence-based assessment in higher education. Ilahi et al., (2014) demonstrate the effectiveness of this approach in e-learning environments, which holds potential for current Maritime Education and Training (MET) settings.

In the maritime context, competence-based assessment aligns with the focus of Standards of Training, Certification, and Watchkeeping (STCW) on measurable skills and knowledge. However, effectively assessing non-cognitive skills like teamwork and decision-making in simulated or written exams is a challenge.

## **3 COMPUTER-BASED ASSESSMENT**

With the advent of technology, modern forms of assessment have emerged that include computer-based assessment. It has growing popularity not just in MET but in higher education at large. Eshaghi (2019) defines computer-based assessment as an electronic system, but its usefulness in simulating real-world maritime scenarios needs further exploration. While Bull et al. (2006) suggest that computer-based assessment helps learners identify knowledge gaps, assessing critical thinking and problem-solving in dynamic maritime environments demands more than just self-reflection.

Thelwall (2000) points out the potential advantages of random-based tests in computer-based assessment,

but randomly generated maritime assessments might not adequately cover essential competencies. Mayer, (2002) emphasizes the importance of aligning assessment items with cognitive skills, but effectively assessing non-cognitive skills like leadership and communication remains a challenge for computer-based assessment in MET. While Hassanien et al. (2013) conclude that the advantages of computer-based assessments outweigh the disadvantages, their study was conducted in a general educational context, neglecting maritime-specific concerns like simulator access and cost-effectiveness.

#### 4 AUTHENTIC ASSESSMENT

Authentic assessment goes beyond traditional methods of assessment by measuring a student’s knowledge, problem-solving skills, understanding, and attitudes in real-life or simulated situations. Brown (2015) stresses the importance of aligning assessment tasks with learning outcomes to increase student engagement and improve their skills. Vu & Dall’Alba (2014) challenge the idea that authenticity is exclusively task-based, suggesting that it is a quality of educational processes that encourages personal growth in students. Villarrol et al. (2018) expand further on this, identifying 13 consistent traits of authentic assessment and proposing a model for its design and implementation in higher education. These studies collectively highlight the need for assessment to be meaningful, relevant, and aligned with learning outcomes in order to promote student learning and development

#### 5 METHODOLOGY

This study employed a combination of document analysis looking into STCW and IMO Model courses and a systematic literature review looking into scholarly articles, delving into existing research on competence-based assessment, computer-based assessment, and authentic assessment. Since there is a big difference between the richness of scholarly articles for competence-based assessment of seafarers and the scholarly articles for computer-based assessment and authentic assessment, a different inclusion and exclusion criteria description was set for competence-based assessment.

Topic	Criteria	Date	Types of record	Setting/Definition
Competence-based assessment	Inclusion	Papers that were published between 2010-2023	Only peer-reviewed journal articles were included.	Papers that focused on competence-based assessment of seafarers.
	Exclusion	Papers that were published before 2010	Papers that were not peer-reviewed were excluded.	Papers that focused on competence-based assessment of fields other than seafaring were excluded.
Computer-based assessment / Authentic assessment	Inclusion	Papers that were published between 2013-2023	Only peer-reviewed journal articles were included.	Papers that defined computer-based assessment and authentic assessment in a similar way to how this study defined them were considered.
	Exclusion	Papers that were published before 2013	Papers that were not peer-reviewed were excluded.	Papers that defined computer-based assessment and authentic assessment in a different way to how this study defined them were not considered.

**Table 1.** Inclusion and exclusion criteria

The aim was to explore how the strengths of authentic assessment could be strategically combined with those of computer-based assessment to tackle the limitations of using solely computer-based assessment to assess competencies within the maritime industry. By analyzing these diverse research sources, the authors sought to identify and evaluate potential solutions for strengthening maritime competency assessment through a blended approach leveraging the advantages of both types of assessment.

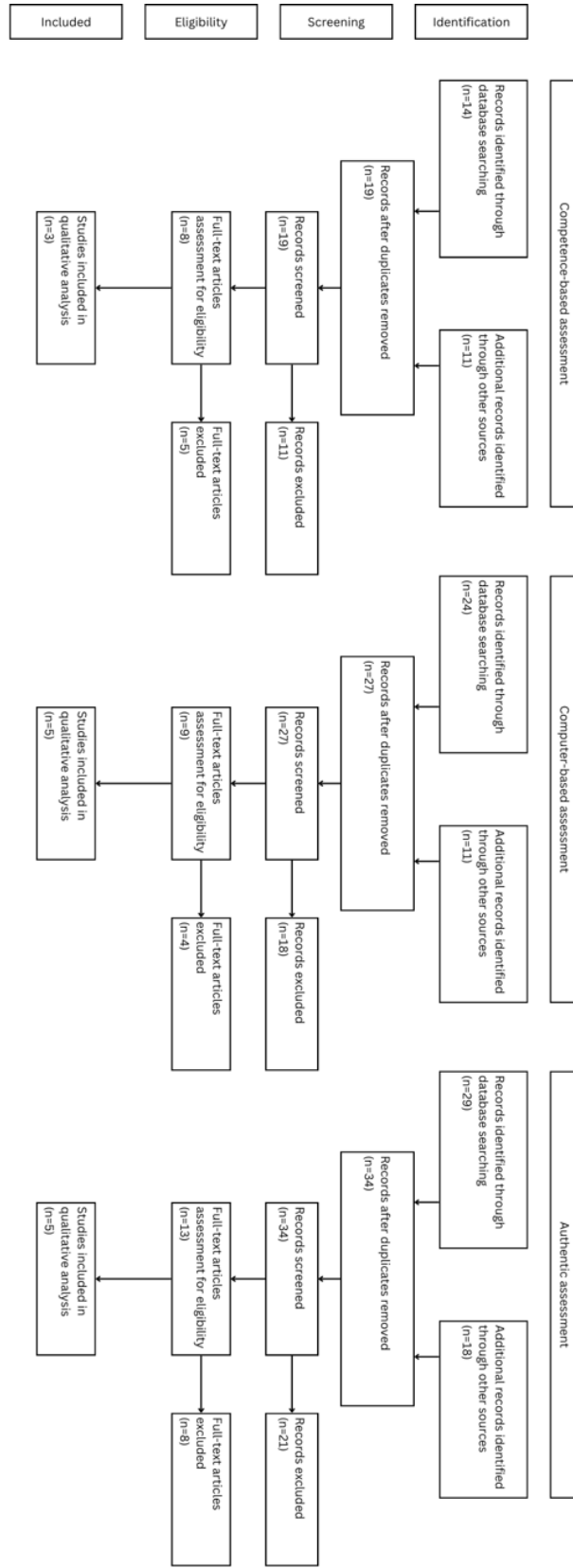


Figure 1. PRISMA Flow Diagram, Moher et al. (2009)

## 6 RESULT AND DISCUSSION

Assessing the competence of seafarers is crucial in ensuring their safety, the safety of the ships, and the protection of the environment. Leaving this unchecked can lead to highly destructive outcomes. With the advancements of the 21st century, the modalities of how this assessment of competence is delivered can vary depending on the specific circumstances.

For the purposes of this discussion, the authors define the following:

**Competence-based assessment:** This type of assessment evaluates seafarers against established industry standards. It can be delivered through various modalities, such as oral examinations, written tests, practical demonstrations, and/or computer-based assessments.

**Computer-based assessment:** This is a modality of assessment that utilizes a computer. It encompasses exams taken on a computer with various question formats, including objective questions (multiple choice, identification, fill-in-the-blanks), and open-ended questions (essays, case studies). It also includes exams using simulators, either those set up with desktop computers or interactive TVs and panels connected to a computer server.

**Authentic assessment:** This type of assessment evaluates a seafarer's ability to demonstrate the required competence in a way that reflects the actual job they will be performing.

While there are benefits to designing competence-based assessments as computer-based tests, we cannot simply neglect their limitations, particularly regarding ensuring the demonstration of required competencies. Through a literature review, this paper identifies the weaknesses of current practices in assessing seafarer competence and the strengths of authentic assessment in improving these systems. The authors then discuss how authentic assessment can be integrated into current practices; the benefits and challenges of this integrated approach; and how maritime administrations or maritime education and training institutions can implement it.

### 6.1 Weaknesses of the assessment of the competence of seafarers

This section identifies inherent limitations in the systems for assessing seafarer competence, regardless of the delivery method. Assessments, in general, may have inherent weaknesses related to design and development, including concerns about reliability, validity, discrimination (Sampson et al., 2011), assessor bias (Lei, 2020), and transparency (Emad & Roth, 2008). However, these issues are not unique to competence-based assessments. They primarily stem from poor design and development of the assessment procedures and the questions/tasks themselves. The authors emphasize that any competence-based assessment, irrespective of the delivery method, should be designed and developed to mitigate inherent weaknesses arising from its construction. Therefore, the authors focus on inherent weaknesses in the assessment systems used by various countries to evaluate their seafarers' competence, regardless of the modality employed. In this regard, the identified weaknesses below are specific to competence-based assessment in the maritime context.

Weakness	Sampson et al. (2011)	Ghosh et al. (2014)	Gundić et al. (2020)
Lack of Standardization and Consistency	Variation in methods and standards across countries	Lack of standardization in assessment methods	Inconsistent assessments
Inappropriate Assessment Methods	Use of inappropriate computer-based assessments	Over-reliance on traditional pen-and-paper tests	Lack of opportunities for practical application
Inadequate Assessment of Non-Technical Skills		Inadequate assessment of non-technical skills like communication and decision-making	

**Table 2.** Weaknesses of assessment of competence for seafarers.

Table 2 reveals that there are major issues with the current methods for assessing seafarer competence. One

of the biggest problems is the lack of standardized and consistent assessment practices across different countries. Even though there is an international standard for seafarer competency, each nation assesses it differently, which can lead to significant discrepancies. This means that a highly skilled seafarer from one country might fail an assessment in another country simply because of differences in the assessment method, not because of their competency. Moreover, the stringency of assessment practices varies considerably among countries, with some nations implementing more rigorous evaluation procedures while others take a more relaxed approach.

Another critical weakness identified in the table is the overreliance on theoretical knowledge over practical skills. While theoretical knowledge is important, it is equally vital to assess a seafarer's ability to apply that knowledge in real-world scenarios. Simply knowing something is different from being able to put that knowledge into practice. This is particularly concerning given the ever-changing and unpredictable nature of maritime environments. The table also highlights that current assessment methods often fail to assess non-technical skills such as teamwork, communication, and decision-making adequately. These skills are equally crucial when it comes to ensuring the safety and efficiency of maritime operations.

The weaknesses identified in the table emphasize the need for a more comprehensive and standardized approach to assessing competence in maritime domains. This approach should not only evaluate theoretical knowledge but also place a strong emphasis on assessing practical skills and non-technical abilities in simulated or real-world settings.

## 6.2 Capabilities and limitations of computer-based assessment

In exploring the optimization of competency assessment for seafarers, it is crucial to delve into the capabilities and limitations inherent in computer-based assessments. Understanding the parameters within which computer-based assessments operate is fundamental, as it delineates the extent to which authentic assessment methodologies can be integrated to ensure a comprehensive evaluation of seafarers' competence. This section provides a concise examination of the capabilities and limitations of computer-based assessments, laying the groundwork for the subsequent exploration of authentic assessment's role in enhancing competency evaluation within the maritime industry.

Capabilities	Eshaghi, (2019)	Burr et al., (2016)	Ilahi-Amri et al., (2017)	ØvergÅrd et al., (2017)
Efficiency and Automation		CBA allows covering more knowledge in less time.	Provides functionalities like collecting evidence and adapting assessments for personalized feedback.	Algorithms achieve moderate correlation with SMEs in specific tasks.
Diverse Question formats and Assessment design	Offers a wider range of question types and incorporates multimedia elements.	Offers a wider range of question types and incorporates multimedia elements..		

**Table 3.** Capabilities of computer-based assessment.

Computer-based assessments exhibit notable capabilities that enhance the efficiency and effectiveness of evaluating individuals' competence. In Table 3, two common themes were determined among findings and discussions from several research papers on computer-based assessment. Through automated processes of computer-based assessment, the assessment can cover a broader scope of knowledge within a limited time frame. It also has advanced functionalities, such as correlating algorithms with human decision-making. This can be instrumental in setting up an assessment that evaluates seafarers' competence in making correct decisions efficiently. Aside from those functions, it is also capable of delivering assessments with a variety of types of questions and tasks, like open-ended questions that can be complemented with multimedia and simulations that can mimic real-world situations.

Limitations	Eshaghi (2019)	Kuo & Wu (2013)	Burr et al. (2016)	Ilahi-Amri et al. (2017)	ØvergÅrd et al., (2017)
Technical	Requires backup	Current technology			

Challenges	plans and alternative methods in case of technical problems.	struggles with accurately assessing complex responses.		
Digital Divide	Students with limited technology experience might require additional training and support.			
Potential for Inaccurate Assessment		Traditional design processes might lead to discrepancies between intended goals and actual skills measured.	Relies solely on submitted evidence and may not fully capture all aspects of competence.	Algorithmic assessment often focuses on a narrow set of parameters.
Cost Considerations	Setting up dedicated e-exam centers with proper equipment is expensive.		Providing equitable access, technical support, and a strong infrastructure requires significant resources.	

**Table 4.** Limitations of computer-based assessment

Like any other type of assessment, computer-based assessment has limitations, and understanding these can lead to resolution and address them. Firstly, since one of its key components is a computer, this entails technical concerns such as system failure (either hardware or software), power interruptions, internet connectivity issues, and many more. While these cannot be completely eliminated, they can be mitigated. For example, investing in cutting-edge technology can ensure that the system is less likely to fail, and having backup plans for power interruptions and internet connectivity issues is essential. Proper maintenance can also help prevent such issues. However, implementing these solutions entails additional costs, which then becomes another concern. Procuring a single simulator software can be very expensive, not to mention investing in backup plans. While there is not much to be done about the cost itself, ensuring that whatever is purchased and paid for is maximized to its full extent is crucial.

These two concerns are relatively easy to notice, making it easier to take action compared to the other two limitations. The digital skills of the students or trainees who will take computer-based assessments can affect their performance, even though it shouldn't be a factor if it is not part of the assessment objectives. Many seafarers are of an older age and some of them may struggle to cope with technological advancements. If the computer-based assessment is designed to be complex and requires a significant level of computer literacy, then the assessment might not be effective for everyone.

The last and most prevalent limitation in the table is the potential for inaccuracy. One simple example of when this can happen is when a question is added to a question bank and the model answer inputted with that question is incorrect. When the system checks the responses of the students or trainees, it could be possible that their answer is correct. However, since the computer only bases its actions on the data and information it has or is given, the result of the assessment may not be accurate.

These are the limitations of computer-based assessment, and they must be taken into consideration when considering how authentic assessment can optimize computer-based assessment to evaluate the competence of seafarers.

### 6.3 Strengths of authentic assessment for addressing weaknesses

In this section, a table is presented that explores the strengths of authentic assessment in education. There is not much scholarly literature on authentic assessment in the maritime context. However, various descriptions of authentic assessment exist in education. Some describe it as a type of assessment that encourages the student

to be authentic, while others describe it as a type of assessment where students can have some influence on the assessment they receive. Only papers that describe authentic assessment in a way that requires students (*seafarers*) to demonstrate their competence in a real-world scenario were considered. This type of assessment evaluates a learner's (*seafarer's*) ability to demonstrate the required competence in a way that reflects the actual job they will be performing. Additionally, authentic assessments in these papers were given in all sorts of methods, so the strengths of authentic assessment are not specific to computer-based assessments.

Strengths	Ghosh (2017)	Ghosh (2018)	Villarroel et al., (2018)	Sokhanvar et al., (2021)	Ghosh et al. (2014)
Focusing on Real-World Application	Authentic assessments are conducted in settings that mimic real-world scenarios.		Studies show it improves the quality and depth of learning achieved by students (Wiggins, 1993; Dochy & McDowell, 1997).	Applying knowledge to practice	Authentic assessment provides opportunities to practice skills
Promoting Deeper Learning and Critical Thinking	Authentic assessments often require students to integrate various competencies and knowledge sets to solve problems.		It fosters the development of critical thinking, problem-solving abilities (Ashford-Rowe et al., 2014).	Improving critical thinking and problem-solving skills.	
Emphasizing Meaningful Assessment and Student Engagement	The real-world nature of authentic assessment can make them more interesting and motivating for students compared to traditional testing methods.	Authentic assessments are likely presented as more interesting and relevant to students as they involve tasks that mimic real-world scenarios.	Authentic assessments improve autonomy, motivation, self-regulation (Raymond et al., 2013; Nicol et al., 2014; Pintrich, 2000).		Authentic assessment helps students to reflect
Ensuring Assessment Quality and Reliability		Enhanced Validity and Reliability through real-world application and multiple methods.			Authentic assessment is based on performance criterion and standards which support learning.

**Table 5.** Strengths of authentic assessment.

Table 5 showcases four strengths that are commonly observed among various research papers. One of these strengths is the real-world application focus of authentic assessment. Since this assessment is designed to imitate real-world situations, it doesn't require students to memorize facts. Instead, they apply their knowledge and skills to solve problems or answer questions they might encounter in their jobs. The second strength of authentic assessment is that it promotes deeper learning and critical thinking. Since students are required to apply their knowledge in a meaningful way, it can potentially enhance their critical thinking skills and encourage deeper learning. The third strength is that it increases student motivation and engagement. Since the assessments have real-world relevance, learners tend to be more engaged and motivated. This is because they can relate to the assessment, appreciate the learning, and understand its significance in their jobs. Finally, authentic assessment ensures quality and reliability by using criterion-based standards that define an acceptable level of performance in real-world settings.

## 7 CONCLUSION

Ensuring seafarer competence is crucial for guaranteeing safety at sea. This can be achieved through proper evaluation of their abilities. However, designing an effective competence-based assessment presents a challenge. Current practices, while adhering to STCW standards for seafarer competency, allow individual states freedom in designing assessments, leading to inconsistencies. Even seemingly minor variations in assessment delivery methods (pen-and-paper, oral, computer-based, or combinations) can significantly impact



results.

Therefore, this paper proposes an integrated approach: leveraging authentic assessment with a computer-based assessment method for seafarer's competence evaluation. Capitalizing on the versatility of computer-based assessments in terms of question formats and design, the evaluation can be divided into two parts:

- Theoretical: Utilizing a random selection of multiple-choice questions (MCQs), open-ended questions, and other relevant formats.
- Practical: Employing simulation assessments.

While leveraging this capability, the inherent efficiency and automation of computer-based assessments should be maximized. Automatic checking and scoring should be meticulously implemented wherever applicable. When computer-based testing serves as the primary assessment modality, authentic assessment comes into play through the design of both theoretical (questions) and practical (tasks) components. Questions should be crafted to assess not just basic comprehension but also critical thinking, knowledge application through decision-making, and problem-solving abilities.

The STCW standards of competence should guide the design of these assessment items (both theoretical and practical). This includes clearly defining how competence should be demonstrated (desired performance level and actions) and establishing the criteria for evaluating it. It's crucial to remember that the STCW sets minimum standards. The assessment can be designed to exceed these slightly to bridge the gap between what the industry requires and the current qualifications.

Furthermore, the limitations of computer-based assessments must be considered during the design phase. A meticulous process of assessment development and design should be implemented, carefully addressing the strengths and limitations of both authentic and computer-based assessment methods.

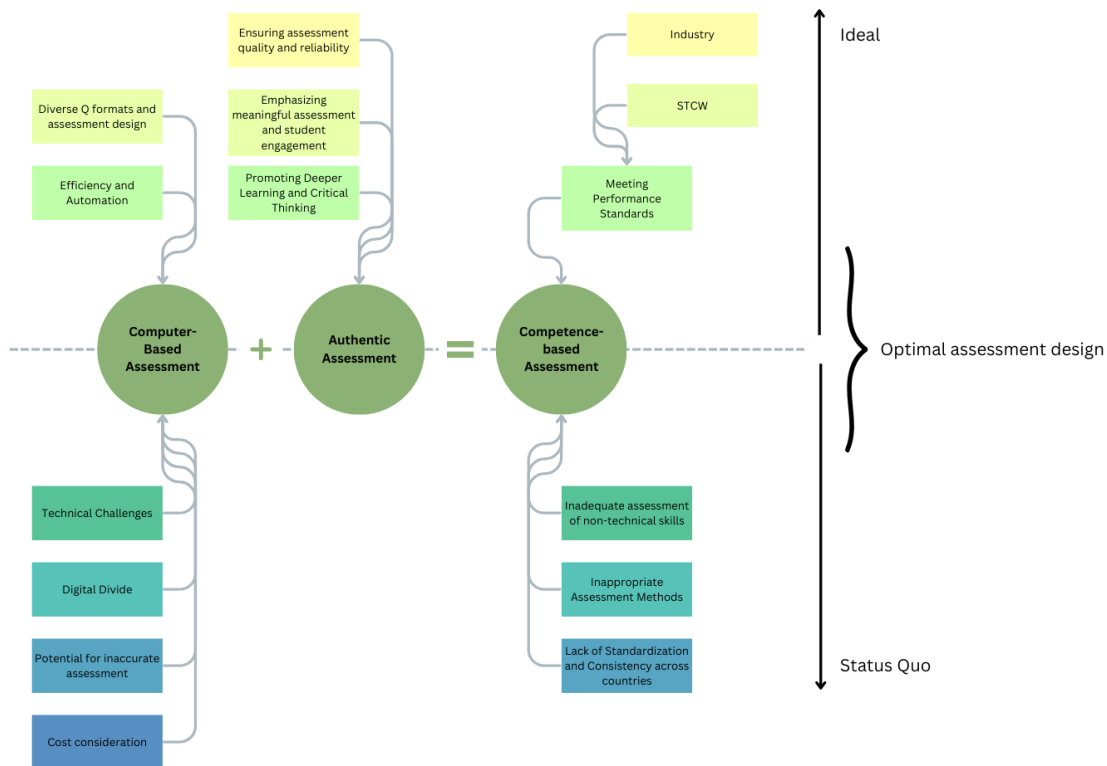


Figure 2. Integration of authentic assessment with computer-based assessment.

## 8 RECOMMENDATION

In the paper, some scholarly articles from various fields were used, as there are still limited papers available specifically discussing maritime context assessments. Therefore, the authors suggest further study to be done in this field to assess these types of assessments in the maritime context.

Moreover, the benefits and challenges of this integrated approach can be evaluated in the future through practical evaluation. This approach can be implemented not just for assessing seafarer's competence but also for evaluating maritime students or cadets in a maritime education and training institution setting.

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