Available online at www.ijournalse.org

Emerging Science Journal

(ISSN: 2610-9182)

Vol. 9, No. 2, April, 2025

Development of a Digital-Based Assessment of Key Competencies for Transformation toward Sustainability: Multi-Assessment Evidence

Chaiwichit Chianchana [1*], Sageemas Na Wichian [2]

[1] *Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand.*

[2] *College of Industrial Technology, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand.*

Abstract

The objectives of this research were to develop a digital-based assessment system for evaluating key competencies for transformation toward sustainability, review the assessment system, examine the dimensions by analyzing multidimensionality, and make predictions using logistic regression analysis. The sample consisted of 449 students for the needs study, 10 experts for system development and assessment, 38 students for system assessment, and 674 students to examine the key competencies. The instruments used were a questionnaire, a focus group discussion record form, an assessment form for students and experts, and an assessment in the digital-based system. Data were analyzed using content analysis, mean, standard deviation, multidimensional analysis, and logistic regression analysis. The results of the research showed the following: 1) Students and experts must develop a digital assessment system. 2) A digital-based assessment system should be developed. This involved personalized assessment through the website. The assessment results were obtained in real-time, and development suggestions regarding each competency were incorporated. The use of the digital-based assessment system demonstrated that the screen, terminology, system information, and system capabilities were at a good level. The experts' assessment showed that the heuristic was at a good level, whereas the utility, interpretation, and accuracy of the system were deemed to be very good. 3) The evidence of the key competencies was multidimensional. In addition, the predictive model regarding academic achievement was consistent with the empirical data, in that seven competencies could be predicted, but two competencies could not. The model predicts academic success 68.50% of the time.

Keywords:

Digital-Base Assessment;
Key Competencies;
Transformation toward Sustainability;
Multidimensional Analysis;
Logistic Regression Analysis.

Article History:

Received:	24	November	2024
Revised:	18	February	2025
Accepted:	04	March	2025
Published:	01	April	2025

1- Introduction

Humans are a vital resource for prosperous development. Specifically, it is essential to identify and cultivate human competence. Competency refers to the capacity, potential, or trait of an individual who is unique and possesses traits that make sense with regard to the competency that is needed for a particular work position and that enable that individual to perform effectively and efficiently [1]. Functional competence is a behavioral trait in which a worker achieves a position to perform a task and undertake a duty with functional competence. The knowledge, abilities, and attitudes that shape an individual's ability to perform a job are also known as competencies. They can be assessed using an organization's established and recognized standards [2, 3]. Competencies are important for human development. Key competencies encompass various concepts that can be used to evaluate value achievement. Strategies-thinking competence [4], tolerance of ambiguity [5], futures-thinking competence [4], integrated problem-solving competence [6], creating new value [7], capacity-building competence, systems-thinking competence, ability to communicate [8], and intrapersonal competence [6] are all competencies that are important in all dimensions, both developmental and predictive, in terms of students' transformation toward sustainability.

* **CONTACT**: chaiwichit.c@fte.kmutnb.ac.th

DOI: http://dx.doi.org/10.28991/ESJ-2025-09-02-016

Competencies for sustainability transformation require reliable and systematic assessment methods. The modern world has entered the digital age, which is an era of major changes in lifestyle and business, in line with the use of digital technology in all aspects of daily life. This digital lifestyle is linked to the use of computers, the Internet, and electronic devices and can be used to expand and develop businesses. This is an important change that has resulted in us adapting and developing new skills to support the reality of using digital technology in all aspects of life and business, while providing opportunities for a comfortable work context and communication in various forms. As a result, every institution that deals with people, whether in the realm of politics, business, society, or education, needs to evolve and adapt to become a fully electronic society (e-society) [9].

The assessment of key competencies for transformation toward sustainability focuses on developing systemic skills and competencies to support changes in various dimensions toward a sustainable society [10]. The assessment of key competencies for sustainability transformation has been developed in a digital format. Digital platforms and assessment technologies are being used to support accurate evaluations that reflect sustainability-related learning outcomes [11]. The development of digital formats for assessing key competencies for sustainability transformation is necessary because digital transformation is crucial to achieving sustainability goals. Digital technologies can effectively enhance assessment capabilities through tools that support data analysis and participatory learning [12, 13]. Furthermore, there is an increasing shift toward digital formats that enable assessments anytime and anywhere with real-time reporting. This is part of efficiently promoting the United Nations Sustainable Development Goals (SDGs) [14, 15]. Currently, there is a gap that requires development in assessing key competencies for transformation toward sustainability in digital formats that can be evaluated anytime and anywhere and provide immediate, real-time reporting [16].

Consequently, a digital system or platform should be used as a modified evaluation mechanism in educational settings. Remaining competitive in a constantly evolving technology landscape requires the application of new technologies, capabilities, and procedures. Learning management is significantly affected by technological advancements and the application of big data [17]. Organizations must have the ability to quickly adapt to change. Digital transformation, such as real-time communication, mobile application development, and mobile workflows, has a direct impact. Paper documentation is limited in terms of time-consuming data collection and immediate evaluation. Digital assessment is a solution regarding overcoming these limitations and can lead to time savings and an immediate reflection of real-time.

Although the use of digital technologies is widespread in education, assessment methods still use traditional approaches, although they are inadequate when it comes to providing information about students' reasoning and understanding concepts. Digital-based assessment can help students learn through inquiry, which is crucial for gaining a thorough grasp of the material under consideration. It also enables teachers to monitor students' progress in real time and to modify their teaching methods to meet the needs of each individual student [17, 18]. In addition, according to Crisp [19], using a digital assessment system can help process and reverse data in a modern and efficient manner and simplify the traditional assessment procedure [20], both in terms of time and resources. Therefore, assessing the digital base is important in a changing world.

Given the importance of key competency issues for sustainability transformation, they must be assessed quickly and in real time to ensure timely development. Therefore, it is necessary to assess key competencies for sustainable transformation using a digital assessment system to develop competencies that are critical to sustainable change in a timely manner. In addition, such a system will provide multi-assessment evidence involving a multidimensional analysis of key competencies for transformation toward sustainability, in conjunction with logistic regression analysis to predict key competencies for transformation toward sustainability in terms of academic achievement. This is necessary to make assessment results credible and to provide in-depth information for the development of students in terms of becoming up-to-date and adapting to the ever-changing environment.

The objectives of this research were to develop a digital-based assessment system for assessing key competencies for transformation toward sustainability, to assess the digital-based assessment system, and to examine the dimensions by analyzing multidimensionality and undertaking predictions involving the use of logistic regression analysis.

2- Literature Review

2-1- Digital Assessment

Digital-based assessment has received considerable attention in the field of education because technological changes and the use of big data play an important role in learning management [17]. This process involves collecting information from learners through various digital channels such as computers, tablets, and mobile phones. This type of evaluation can help process and reverse data quickly and in a modern manner [20], thereby allowing for efficient and fast data analysis and processing. Digital assessments also allow instructors to track student progress in real-time and tailor teaching styles to the needs of each learner [17]. Digital assessment also allows instructors to track student progress in real-time and tailor their teaching style to each learner's needs [21]. It can also help improve assessment effectiveness by using artificial intelligence (AI) and data analysis tools [22].

The importance of digital-based assessment includes the following:

- Promotes learning innovation: The use of assessment technology helps create more engaging and realistic learning experiences.
- Helps develop students' problem-solving skills and creativity [23].
- Allows teachers to provide faster and more accurate feedback when processing and analyzing student learning data, thereby improving the efficiency of teaching and learning processes [24].
- Helps reduce the stress associated with traditional exams through flexible assessment formats and interesting interactions.
- Reduces paper use in assessment systems, thus promoting sustainability and reducing environmental impact [25].
- Helps instructors understand learners' specific needs through real-time assessment data analysis, enabling teachers to plan lessons that better respond to individual learners' weaknesses and needs [26, 27]. It also provides benefits in designing appropriate and sustainable assessments for both students and teachers [28].

The adoption of a digital-based assessment system also simplifies the traditional assessment process. In terms of time and resources [19], digital-based assessment has become an important tool in the education system, which has evolved. Digital technology allows the assessment process to be performed accurately. It is effective and can be customized to suit each learner. Digital assessment allows for the collection of more data in a short time and provides quick feedback, which has a positive impact on the student learning process [29]. In addition, digital assessment can reduce teachers' workload when assessing learning outcomes and can provide flexibility for their use. This has led to the creation of diverse tests and assessments that cover different learning dimensions [30]. Another advantage of digital assessments is their ability to assess complex skills such as problem-solving and critical thinking, both of which are difficult to assess using traditional methods [31]. This process can also increase assessment flexibility, allowing for a wide range of test designs, including the use of multimedia or games to promote learning [32], as well as optimizing assessment, especially in the case of large numbers of learners. It also allows tests to be tailored to the specific needs of each learner. [33]. This assessment also reduces scoring errors due to instructor bias and helps to keep data safe and systematic [34]. In addition, digital assessment promotes the use of innovations and tools that improve accuracy, such as adaptive assessment, which can adjust difficulty levels according to learners' abilities [35].

2-2- Principles of System Development

Kendall & Kendall [36] proposed the following steps to develop a system model: 1) Clearly analyze the elements of the input factors, processes, and outputs of the system, 2) Design the system elements in terms of the input factors. The production process needs to be of the highest quality in order to suit the conditions of the organization and the environment in which the system is used, and 3) In terms of the implementation of the designed system, test the system by testing it out in a simulated or real-world scenario to test whether or not the system is of good quality. Thus, defects in the elements can be identified and corrected.

In addition, Lior [37] presented the creation of a model using user-centered design (UCD), the core philosophy of which is the capabilities and needs of the end user. This can be used to drive the design at each stage of the process. Users' scenarios, personalities, and needs are created, evaluated, and considered from the beginning of the product creation cycle. The information collected during the initial stage is used to determine the features of the product, and the end part is the user experience. Once the product has been designed, it is tested with the assistance of the user, and user feedback is used to refine the characteristics of the product to make it more complete.

2-3- Development of an Assessment System

The development of an assessment system refers to improving the system by creating methods and processes for measuring and evaluating learning outcomes. The aim is to achieve accuracy and consistency with educational goals. The development of assessment systems encompasses not only the assessment of educational achievement but also the development of skills and abilities necessary for life [38]. Whether it concerns the knowledge, skills, or attitudes of learners, such a system relies on modern technology and innovation to increase the efficiency of the assessment process [39].

The development of assessment systems is of great importance in modern times because technological and educational changes have created the need to improve assessment methods to make them more efficient and fit for purpose. A quality assessment system should focus on transparent and accurate assessment that aligns with the needs of learners and instructors [40]. Good assessment not only focuses on measuring academic achievement. It is also necessary to assess competencies related to the development of social skills and problem-solving in real-life [41].

The development of an assessment system is also important for creating continuity and transparency when providing feedback. This allows learners to continuously improve and develop. Effective assessment should not only focus on grading but also on providing guidance and information that can be used to improve learners [42, 43]. In addition, the development of assessment systems in the digital era also promotes the use of technology to track and analyze learning behaviors. This allows instructors to use the data to improve teaching and instruction more quickly and effectively [44]. In addition, it should be designed to suit the context of learners in such a way as to support diverse learning and promote lifelong learning [45].

Currently, gaps exist in the development of digital assessment tools for key competencies for transformation toward sustainability that can be evaluated anytime and anywhere and provide immediate results. This includes creating customizable tools that meet specific user needs. Real-time measurement and connecting insights across multiple dimensions remain limitations that need to be addressed to support development with concrete and sustainable outcomes at all levels [16]. The development of digital formats for assessing key competencies for sustainability transformation is necessary because digital transformation has become a crucial process in driving sustainability goals. Digital technologies can efficiently enhance assessment capabilities through tools that support data analysis and participatory learning [12, 13]. The aim is to enable assessment anytime and anywhere with real-time reporting, which is part of effectively promoting the Sustainable Development Goals (SDGs). The use of digital technologies, such as platforms for data collection and analysis, is being implemented to assess students' sustainability competencies, provide immediate feedback, and help learners interact more deeply with environmental content [14, 15]. The current assessment of key competencies for sustainable transformation focuses on developing systemic skills and competencies to accommodate changes in various dimensions [10], emphasizing digital development. Digital platforms and assessment technologies in both education and training, such as data-driven assessments and big data analytics, are being used to support accurate assessments that reflect sustainability-related learning outcomes [11].

2-4- Assessment Framework of Sustainability Transformation

Sustainability is increasing; however, many challenges remain and are important to education [46, 47]. This is because it is constantly changing, which has important characteristics: transformation toward sustainability as follows: Strategies-thinking competence is a person's ability to think conceptually, imagine systematically, and bring opportunities to success. It relates to developing a broad perspective, emphasizing a competitive advantage, and connecting the vision effectively [4]. The tolerance of ambiguity is the ability to face complex new situations and recognize uncertainty [5]. Futures-thinking competence is the ability to predict by modeling what will happen and is related to forecasting for future development, understanding the probabilities of what is desired, and analyzing and evaluating what is expected to happen in the future [4].

Integrated problem-solving competency is the ability to use a problem-solving process to solve complex problems. These involve developing integrated work and options for solving possible problems. It also integrates problem analysis into evaluation and strategy creation [6]. Creating new value is the ability to think about value. Creating new value, operating with insight, and thinking about new techniques and solutions are all characterized by "thinking outside the box [7]." Capacity-building competency defines the ability to strengthen capacity. This is partly motivated by the use of good role models who inspire others and keep others engaged so that the group feels a sense of ownership and shared responsibility [8].

Systems-thinking competence is the ability to think in the context of an environmental system dealing with a wider society by linking existing data. This involves analyzing the dynamics of the social ecosystem, analyzing system changes and problems, and understanding the ecosystem. The ability to communicate is the ability to convey messages through various media, social media, and symbols correctly and appropriately by using writing and body language to meet the chosen objectives. Communication relates to receiving information and interpreting it correctly, as well as presenting it to others, including accepting creative feedback from others and knowing how to listen to such feedback [8]. Intrapersonal competence refers to the ability to take care of oneself and focus on flexibility, having awareness and self-control, setting life goals, and being responsible for oneself [6].

2-5- System Quality Assessment

The evaluation of system use can be divided into three main areas as follows: screen, terminology and system information, and system capabilities [48-50]. Nielsen [51] heuristic evaluation consists of 10 principles that are used as criteria for evaluating the usability of a system. These are as follows: Visibility of system status; Match between a system and the real world; User control and freedom; Consistency and standards; Error prevention; Recognition rather than recall; Flexibility and efficiency of use; Esthetic and minimalist design; helping users recognize, diagnose, and recover from errors; and help and documentation. Furthermore, standard-based evaluation focuses on three main aspects: accuracy, utility, and data interpretation. The accuracy of data is important in decision-making and strategic planning [52]. Utility indicates that evaluation must be practical, which means that the evaluation results must be able to be used in further development to improve or plan activities effectively and respond to user needs [53]. The ability to interpret data appropriately is essential for understanding assessment results. The data must be presented in a form that can be used and interpreted correctly [54].

3- Conceptual Framework

The development of a digital assessment system for assessing key competencies for transformation toward sustainability, in which the digital system is developed with a user-centered design (UCD) [37], consists of need assessment, designing, building, and testing. These are the key competencies for transformation toward sustainability, which consist of strategies-thinking competence, tolerance of ambiguity, futures-thinking competence, integrated problem-solving competence, creating new value, capacity-building competence, systems-thinking competence, ability to communicate, and intrapersonal competence. They operate when a digital-based assessment system is developed to assess key competencies for sustainability transformation.

The quality of the system was evaluated by including an assessment of the use of the system [48-50], heuristic evaluation [51], and standard-based evaluation. This leads to the assessment of vocational education students in such a way as to reflect the results of the assessment in real time. The identification of development approaches is personalized. When the assessment is completed, the evaluation evidence is presented by examining the dimensions of key competencies for transformation toward sustainability using multidimensional analysis. The prediction of key competencies related to academic achievement involves the use of logistic regression analysis (Figure 1).

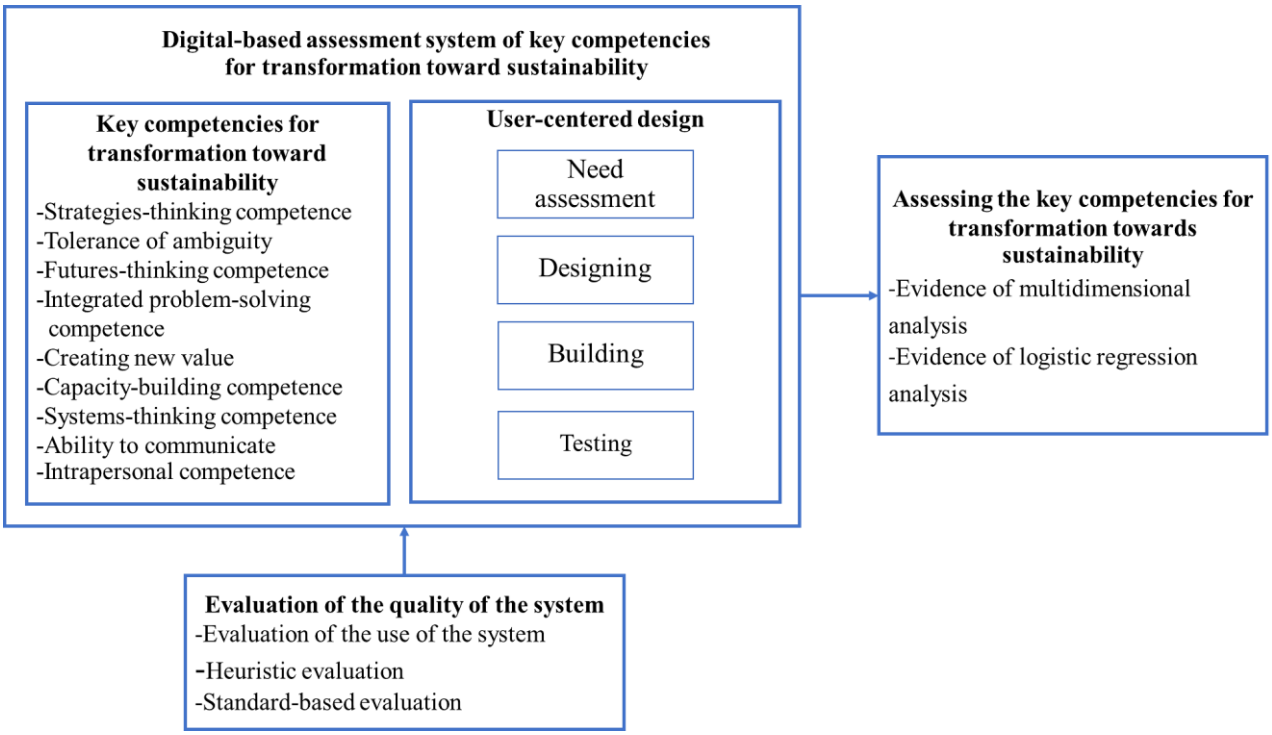

Figure 1. Conceptual framework

4- Research Methodology

This research uses research and development in the first phase and descriptive research in the second phase. The first phase is the development of a digital assessment system to assess key competencies for sustainability transformation. Development consists of Needs Data Study, Design, Construction, and Testing [37]. The second phase is the development of an evaluation system, whereas the third phase examines the key competencies for sustainability transformation using multidimensional and logistic regression analyses. The following sections describe each phase of the research process, including the samples, research tools, data collection, and data analysis. The details are as follows:

4-1- Development of a Digital-based Assessment System to Assess Key Competencies for Sustainability Transformation

1) Research Procedures

- Study the needs regarding assessing key competencies for transformation toward sustainability using of a digital-based assessment system with students.
- Design of a digital assessment system to assess key competencies for transformation toward sustainability. This will be characterized by input data with regard to 9 competencies which students will provide through a digital-based system. The data will go through an assessment process, and the system will process the real-time assessment. The assessment results include reflecting on each competency level and identifying development guidelines based on personalized competencies (Figure 2).

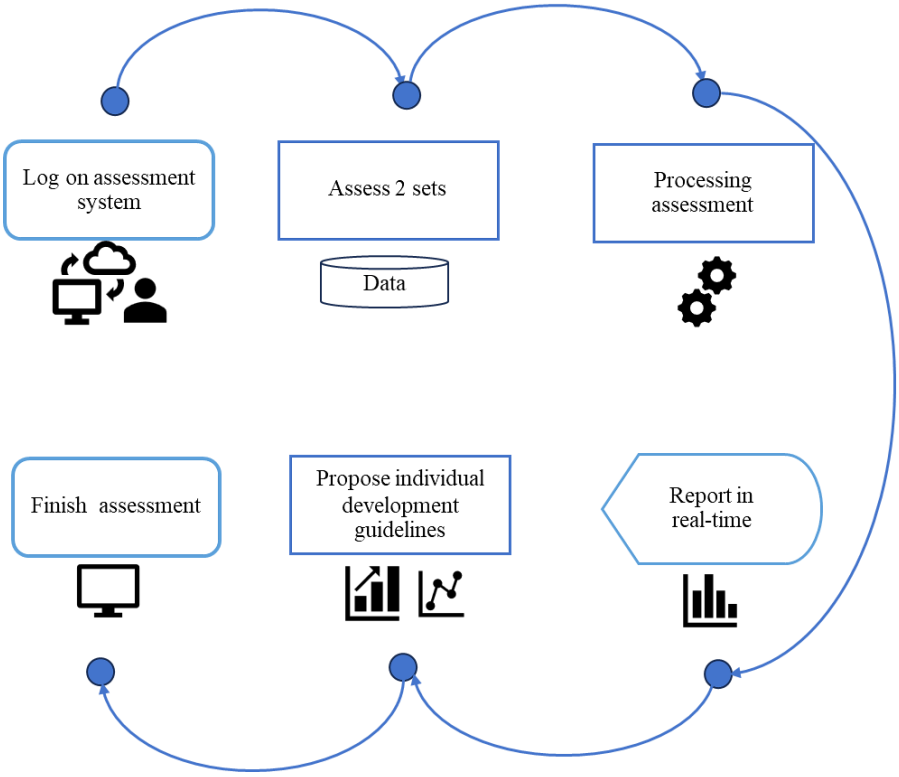

Figure 2. Design of a digital assessment system

2) Sample

- According to the minimum sample size given by Kanjanawasee et al. [55], a sample of students attending technical colleges was selected. At least 400 should be included in the sample to obtain a population with infinite features, a 95% confidence level, and an error of ±10. The samples were obtained via stratified random sampling. The population was divided into 5 regions: North, Northeast, Central, East, and Bangkok, and South, with 5 colleges being chosen at random, with 449 students.
- Regarding the expert group for system development and evaluation, Patton [56] proposed a minimum of 6–12 people for group discussions. Purposive sampling was used to obtain a group of 10 individuals with expertise in measurement, evaluation, and educational technology. Each participant had more than 10 years of work experience in the respective fields.
- Johanson & Brooks [57] proposed that the minimum size of the pilot study should be 30 students. A random sample of 38 students from SaKaeo Technical College were selected.

3) Instruments

- Questionnaire for collecting data to study the needs of students. The content validity of the questionnaire was reviewed by 5 experts with the use of the content validity index for scale (S-CVI). It was found to be 0.95 while the content validity for item (I-CVI) was between 0.80 and 1.00.
- A group discussion record form to check the quality of the content accuracy tool by checking for language appropriateness. The language was found appropriate for group discussions. There were minor adjustments to the questions.
- Assessment form for the digital-based assessment system. The quality of the content validity tool was reviewed by 5 experts with the use of the content validity index for scale (S-CVI). It was found to be 0.93, and the content validity for item (I-CVI) was between 0.80 and 1.00.
- Assessment form for the digital-based assessment system for assessing key competencies for transformation toward sustainability for experts. The quality of the content validity tool was reviewed by 5 experts with the use of the content validity index for scale (S-CVI). It was found to be 0.93, and the content validity for item (I-CVI) was between 0.80 and 1.00.

4) Data Collection and Analysis

This involved gathering data and educating the participants about the goals of the study. The benefits of this research, which include data collection at this point, provide the participants with useful information. Students' and parents' permission to participate in the study was coordinated with the research participants' educational institutions to allow the researcher to gather data from students online. The experts provided consent before gathering information online. Data analysis using content analysis, averages, and standard deviations.

4-2- Examine Key Competencies for Sustainability Transformation Using Multidimensional and Logistic Regression Analysis

1) Research Procedure

- Examination of data on key competencies for transformation toward sustainability obtained from the digital-based assessment system.
- Conduct an analysis and summarize key competencies for transformation toward sustainability using multidimensional analysis, which was used to examine the 9 competencies.
- Conduct an analysis and summarize key competencies for sustainability transformation using logistic regression analysis. This model uses predictive variables as key competencies for sustainability transformation. There are 9 competencies and the variables with regard to academic achievement are the criterion variables.

2) Sample

- The minimum sample size from the table by Kanjanawasee et al. [55] was used to determine the number of students attending technical colleges. To obtain a population with infinite features, a 95% confidence level, and an error of ±10, the sample size must be at least 400, and the minimum by item response theory on the Rash model must be at least between 200 and 500 people [58]. The minimum was determined by logistic regression analysis with a 10:1 ratio of predicted variables. Given that there were 9 variables, a minimum of 90 people [59]. This number was generated using stratified random sampling. The sample was obtained from five regions: North, Northeast, Central, East, and Bangkok, and there are 5 colleges as random units for each college, with 674 students.

3) Instruments used in the research

- Assessment of key competencies for sustainability transformation in the digital-based assessment system. The 9 competencies were strategies-thinking competence, tolerance of ambiguity, futures-thinking competence, integrated problem-solving competence, creating new value, capacity building competence, systems-thinking competence, ability to communicate, and intrapersonal competence, including the 36 situation tests and the checklist 9 items.

4) Data collection and analysis

Data collection helps participants understand the goals of the study. A benefit of this research, which included data collection, was that it provided volunteers with useful information. Consent from students and their parents to gather data online through collaboration with the participants' educational institutions was obtained. Data analysis was performed using logistic regression and multidimensional analysis.

4-3- Research Ethics

Ethics regarding human subject research in the social sciences are upheld in this study. This study was approved by the Ethics Committee of Naresuan University (No. 0063/2023).

5- Results

5-1- Develop a Digital-based Assessment System to Assess Key Competencies for Transformation Toward Sustainability

5-1-1- The Results of the Study on the Need to Develop a Digital Base Assessment System

The results of the study on the need to develop a digital-based assessment system for assessing students' key competencies for transformation toward sustainability found that all of the students' responses to the questions set indicated a high demand for the development of such a system. Half of the respondents agreed on the need to develop a digital-based assessment system (Table 1). Of the respondents, 50.33% said that digital tools are convenient and fast (n = 60), followed by easy access (n = 21) and modern (n = 16). Only a very small number of respondents disagreed (1.34%). However, a proportion of students did not provide their opinions (48.33%).

Table 1. Need to develop a digital-based assessment system to assess students' key competencies for transformation toward sustainability (n = 449)

List	Mean	Sd	Interpretation
1. Key competencies for sustainability transformation	3.94	0.961	High
2. The key competencies for sustainable transformation toward sustainability should be evaluated continually.	3.87	0.988	High
3. The assessment should be easy to understand.	4.10	1.012	High
4. Assessments should be recorded in digital format	4.07	0.952	High
5. The assessment should be digital and should be able to report results in a timely and immediate manner (in real time).	4.11	0.978	High
6. Assessments should be digital and easily accessible. It should not be complicated.	4.17	0.970	High
7. Assessments should be digital in a form that supports big data	4.09	0.949	High

5-1-2- The Results of the Study on the Development of a Digital Base Assessment System

The results of the study on the development of a digital-based assessment system for assessing the key competencies for transformation toward sustainability for students according to experts' opinion indicate that there was a need to create such a situation to allow students to remain up-to-date. It should be convenient, fast, economical, and cost-effective. There were several comments:

- From the evaluation framework, it would be good if a digital assessment system was created… (Expert 1);
- The assessment system needs to be developed digitally to save both time and money. (Expert 3);
- From the framework, it is considered that there are a lot of performances… (Expert 4);
- It is necessary to have a sustainable change competency assessment system that will be created digitally. Students will be able to apply it quickly and anywhere. (Expert 5);
- It can be considered that the 9 competencies are important and quite diverse. Digital development would be appropriate, but it is also necessary to consider the time when students need to make assessments. Don't get too much... (Expert 6).

In terms of the characteristics of the digital assessment system, the study found that the system must be responsive to students who provide the necessary information. Consequently, instant real-time assessment results are required. It should be a simple system that is not complicated and must show development guidelines. There were several comments:

- The digital assessment system must be responsive to students who will respond to the information. It doesn't take too much time, and there is a lot of wow... (Expert 5);
- A digital assessment system must be user-friendly for the person providing the information… (Expert 9);
- The assessment system must be colorful and display real-time evaluation results immediately for each participants... (Expert 7);
- The competency assessment system does not take too much time, probably 20-25 minutes, so that the children can concentrate on the assessment… (Expert 2);
- Digital Assessment System in addition to displaying the results in real time, the evaluation results must also have a development approach to cover the term assessment... (Expert 7).

5-1-3- Results of Developing a Digital Assessment System for Assessing Key Competencies for Transformation toward Sustainability

- It is necessary to design a digital-based assessment system for examining the 9 key competencies for transformation toward sustainability. Students must provide information on all 9 competencies through a digital-based system. After the data is assessed, the system will process the real-time assessment. The development guidelines will be identified based on personalized competencies.
- Following the results of creating a digital assessment system for assessing key competencies for sustainability transformation through the website.

Assessment System Structure:

This will take the form of an Assessment of Key Competencies for Transformation toward the Sustainability System (ASK-CTS). This is a frontend and backend system. The ASK-CTS system consists of a frontend called ReactJS, a backend called ExpressJS, and a database called PostgresQL. These are as follows: 1) The frontend was chosen to be ReactJS by using the TypeScript language for development. This is a language with types, making it easy to control the

type of data and maintain it; 2) the backend was chosen to be ExpressJS. This is an instrument used to create RESTful using JavaScript language running on NodeJS, which is a popular concept in modern application architecture and helps to develop, maintain, and expand the system efficiently; and 3) PostgresQL was selected for the Database. This is an object-based database management system with more features than MySQL and flexible data integrity for both types of data. The proposed model has both scalability and concurrency. This system was suitable for the productivity characteristics of the ASK-CTS system, including work flexibility, data linkage, maintenance, effective amplification, and instant display of individual data (See Figures 3 and 4).

```
function App() {
  const [isLoading, setIsLoading] = React.useState(false)

  return (
    <div className="App">
      <AppContext.Provider value={{ setIsLoading }}>
        {isLoading ? <Loader/> : (
          <Routes>
            <Route
              path="/"
              element={
                <ProtectedRoute>
                  <LayoutComponent title="Summary">
                    <Summary />
                  </LayoutComponent>
                </ProtectedRoute>
              }
            />
            <Route
              path="answer/:id"
              element={
                <ProtectedRoute>
                  <LayoutComponent title="detail">
                    <Answer />
                  </LayoutComponent>
                </ProtectedRoute>
              }
            />
            <Route path="testing/" element={<Testing />} />
            <Route path="/login" element={<Login />} />
            <Route path="/forgotpassword" element={<ForgotPassword />} />
            <Route path="/resetpassword/:data" element={<ResetPassword />} />
          </Routes>
        )}

      </AppContext.Provider>
    </div>
```

Figure 3. Example code samples from the ASK-CTS system developed using ReactJS in Frontend

```
const express = require('express')
const router = express.Router()
const { QuestionOptions, Questions, sequelize } = require('../models')
const { getAllExamsDetail, getEvaluateExam } = require('../repositories/exam.repository')

router.post('/createExam', async (req, res) => {
  const transaction = await sequelize.transaction();
  try {
    for (const question of rawData) {
      const { options } = question
      const newExam = await Questions.create({
        question: question.question,
        exam_id: 2
      }, { transaction })
      await QuestionOptions.bulkCreate(options.map((option, index) => {
        return {
          label: option.label,
          question_id: newExam.id,
          score: option.score,
          order: index + 1
        }
      }), { transaction })
    }

    await transaction.commit()
    return res.status(200).json({
      success: true,
      message: 'success'
    })
  } catch (error) {
    await transaction.rollback()
    console.error(error)
    throw new Error(error.message)
  }
})
```

Figure 4. Code samples for developing APIs from the ASK-CTS system developed with ExpressJS in the backend

The characteristics of the informants that will be entered into the assessment system through the website at *https://university-exam-6a351.web.app/testing* are shown in Figures 5 and 6.

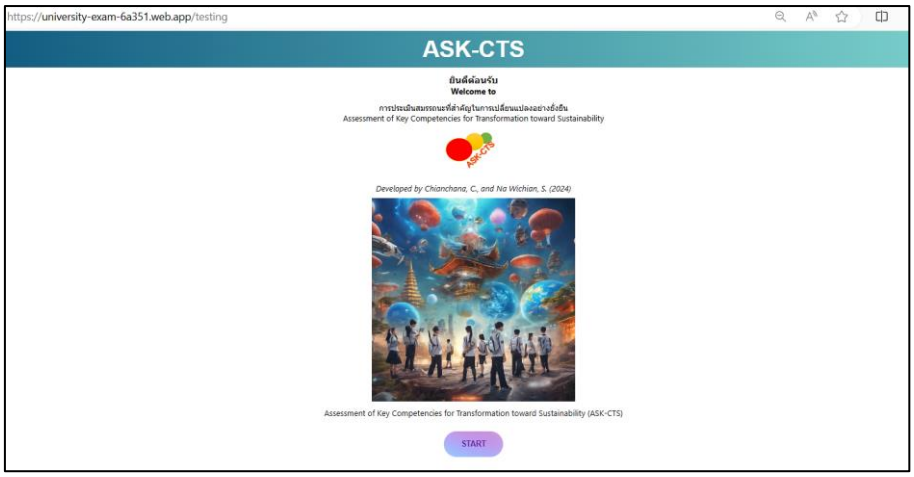

Figure 5. Characteristics of the respondents will be entered into the assessment system (*https://university-exam-6a351.web.app/testing*)

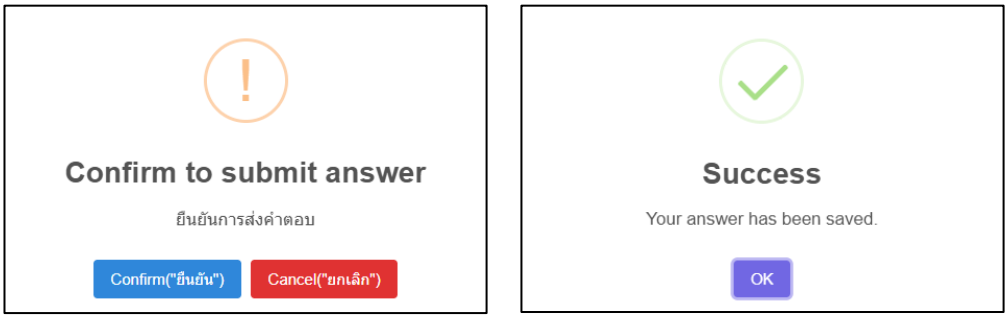

Figure 6. Submit Assessment Responses

Examples of assessment results include student scores. The 3 levels of assessment results (low, medium, and high) and the development guidelines for each competency are shown in Figure 7.

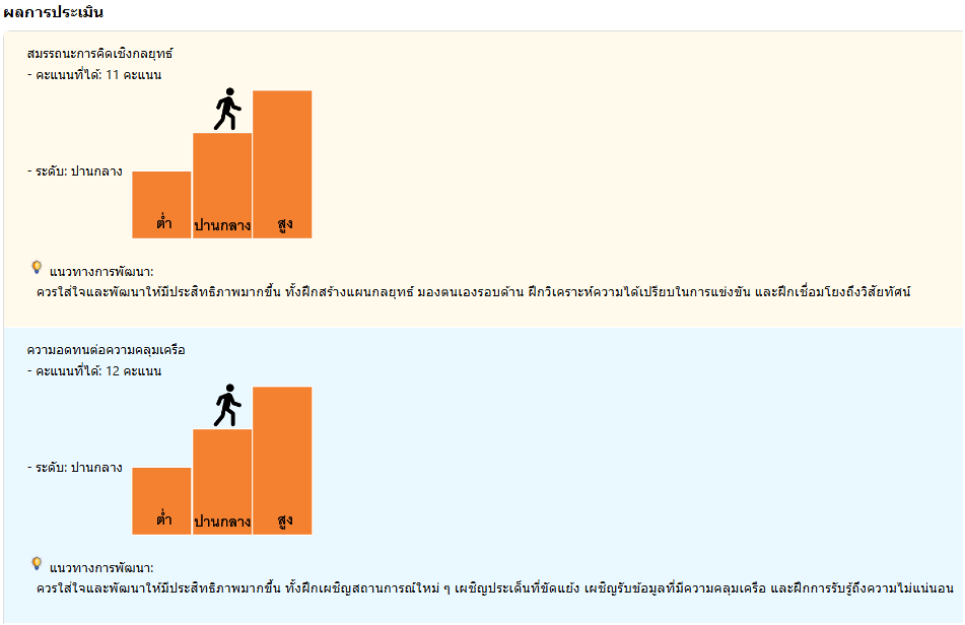

Figure 7. Examples of assessment results

The characteristics of the administrator are the appearance of the reply information. The results for individual assessments obtained through the website at https://university-exam-6a351.web.app/login are shown in Figure 8.

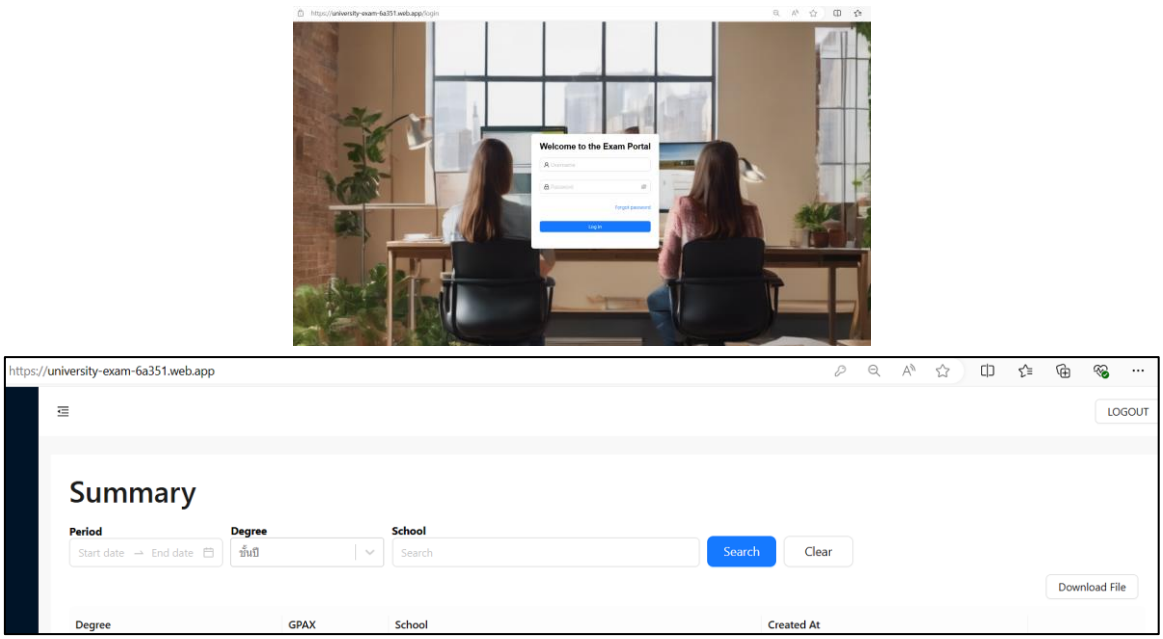

Figure 8. Characteristics of the administrator are the appearance of the reply information (*https://university-exam-6a351.web.app/login*)

5-2- Results of the Digital-based Assessment System for Assessing Key Competencies for Transformation toward Sustainability

5-2-1- Assessment Results of the Digital Assessment System of Key Competencies for Transformation toward Sustainability (for Students)

Assessment results of the ASK-CTS system for students at Sakaeo Technical College involved 38 participants. The situational version has a reliability of 0.76, and the checklist version has a reliability of 0.86. Hair et al. [60] proposed criteria for considering reliability using Cronbach's alpha coefficient, suggesting that values of 0.70 and above should be accepted. The results of the assessment of the digital-based system indicated that a total of 35 people found the screen, terminology, system information, and system capabilities to be good. The mean values were 3.71, 3.72, and 3.84, respectively.

5-2-2- Assessment Results of the Digital Assessment System of Key Competencies for Transformation toward Sustainability (for Experts)

In terms of the applied heuristic assessment and standard-based assessment in the assessment of digital-based assessment systems for assessing key competencies for transformation toward sustainability (for Experts), the overall evaluation of the heuristic was at a good level. When considering each item, 7 items were deemed to be at a good level, while 3 items were considered to be very good (Reliability = 0.79). The standard-based evaluation found that in terms of utility, interpretation, and accuracy, the system was deemed to be very good, with reliability equal to 0.86, 0.79, and 0.92, respectively.

Other suggestions from experts. It was suggested by some experts that the letters should be as follows:

"*It is too small, and the instructions should be written more clearly. Everything must be user-friendly. In this sense, the problems were succinct. However, the temple had quite a lot of questions. Therefore, the system screen should be adjusted to be less academic so that it becomes more interesting and attractive for users to answer. In some questions, although it was unclear whether the wording was intentional or that the question was not completed, no problem was found in using it. The format was simple. The digital base ASK-CTS system was deemed useful and interesting, but some items could be evaluated with more than 1 item (it is better to specify the instructions clearly). It was thought to be very user-friendly, and the evaluation results were concise and clear*."

5-2-3- Assessment Evidence of Key Competencies for Sustainability Transformation Using the Digital-based Assessment System

The data contributors included 137 participants from the North (20.33%), 136 from the Northeast (20.18%), 126 from the Central Region (18.69%), 139 from the East and Bangkok (20.62%), and 136 from the South (20.18%), totaling 674 people.

Assessment results of key competencies for sustainability transformation using the digital-based assessment system. The evidence of the reliability of the situation test was 0.80 and the checklist was set to 0.84. The results of each assessment show that most competencies were at the moderate level, followed by high and low levels. The results are shown in Figure 9.

Figure 9. Assessment results of key competencies for sustainability transformation using the digital-based assessment system

5-2-4- Results of Assessing Students' Satisfaction with the System

The reliability of the satisfaction assessment instrument was 0.96. The results demonstrated that the screen, terminology, system information, and system capabilities were at a good level. The mean values were 3.64, 3.67, and 3.70, respectively (Table 2).

Table 2. Results of the assessment of students' satisfaction with the system)n = 506(

List	Mean	SD
Screen		
1. Text format and various components on the screen	3.63	0.94
2. Use of on-screen tools	3.64	0.89
3. On-screen information management	3.65	0.91
4. The display sequence and components on the screen	3.63	0.89
Total	**3.64**	**0.91**
Terminology and System Information		
5. Use of terminology in different parts of the system	3.61	0.95
6. Relationship between computer terminology and the tools used	3.68	0.87
7. Location of message on screen	3.65	0.89
8. On-screen text display for the user	3.76	0.90
9. Status notifications of what is being done	3.61	0.92
10. Continuous tool working	3.73	0.93
Total	**3.67**	**0.91**
System Capabilities		
11. System data collection capability	3.68	0.90
12. Speed of system data processing	3.74	0.89
13. System accuracy	3.73	0.86
14. Confidence in system operation	3.68	0.86
15. Ability to operate the system (no jamming during system use).	3.69	0.91
Total	**3.70**	**0.89**

5-2-5- Results of the Dimensional Examination of the Key Competencies for Sustainability Transformation using Multidimensional Analysis

1) Examining the fit of key competencies for sustainability transformation

This analysis applies the Multidimensional random coefficients multinomial logit model (MRCMLM) [61] in the form of a Multidimensional Partial credit model. The situation test found that Infit (Unweighted fit) ranged from 0.73 to 1.35, while Outfit (Weighted fit) ranged from 0.89 to 1.23. The checklist found that Infit (Unweighted fit) ranged between 0.65 and 2.43, and the Outfit (Weighted fit) ranged between 0.69 and 1.46.

2) These results provide evidence of multidimensionality analysis of key competencies for sustainability transformation.

The results of the examination of the evidence of multidimensionality showed that both the situation test and the checklist based on the deviation statistic, the multidimensional approach was statistically significantly more appropriate than the composite approach at a level of 0.01. This approach was more appropriate than the consecutive approach, indicating that the key competencies for transformation toward sustainability were the multidimensional approach, according to the criteria proposed by Allen & Wilson [62]. A model with a lower value indicates a model with better consistency with empirical data. In other words, when evaluating and interpreting key competencies for sustainability transformation, it is necessary to consider the multidimensional characteristics, which consist of 9 dimensions. The measurement results of the situation test and checklist are shown in Tables 3 and 4.

Table 3. Evidence of multidimensionality of key competencies for transformation toward sustainability (Situation test).

Key competencies	Deviance Statistic (G^2)	Number of parameters	AIC
Composite approach	44,780.983	73	44,926.983
Consecutive approach	45,622.100	81	45,784.100
Multidimensional approach	44,560.764	117	44,794.764
Comparison between the multidimensional and composite approaches Likelihood ratio chi-squared statistic (G^2): $\chi^2 = 220.219$, df = 44, $p < 0.01$			
Comparison between the multidimensional and consecutive approaches Akaike Information Criterion (AIC): 44,794.764 < 45,784.100			

Note: The difference χ^2 (df = 5, $\alpha = 0.01$) is equal to 15.086

Table 4. Evidence of multidimensionality of key competencies for transformation toward sustainability (Checklist).

Key competencies	Deviance Statistic (G^2)	Number of parameters	AIC
Composite approach	28,197.644	37	28,271.644
Consecutive approach	30,012.748	45	30,102.748
Multidimensional approach	28,170.155	81	28,332.155
Comparison between the multidimensional and composite approaches Likelihood ratio chi-squared statistic (G^2): $\chi^2 = 27.489$, df = 44, $p < 0.01$			
Comparison between the multidimensional and consecutive approaches Akaike Information Criterion (AIC): 28,332.155 < 30, 102.748			

Note: The difference χ^2 (df = 5, $\alpha = 0.01$) is equal to 15.086

Evidence of the validity of key competencies for transformation toward sustainability is shown with a Wright map, which is an index indicating the difficulty of the question for respondents who have the ability and opportunity to answer it correctly. This assessment assesses the key competencies for transformation toward sustainability of students across 9 multidimensional aspects. In the situational version, the dimension with the most widely distributed difficulty is tolerance for ambiguity (TOA), and in the checklist version, the dimension with the most widely distributed difficulty is creating a new value (CNV) (Figures 10 and 11).

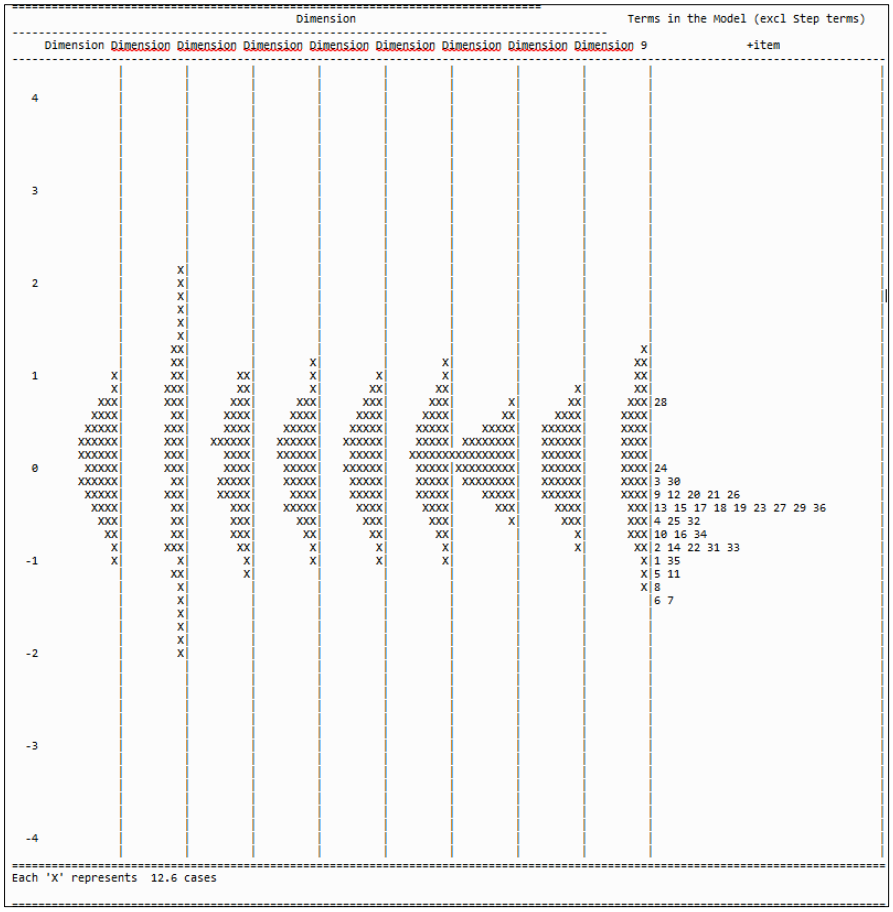

Figure 10. Wright map of the situation test

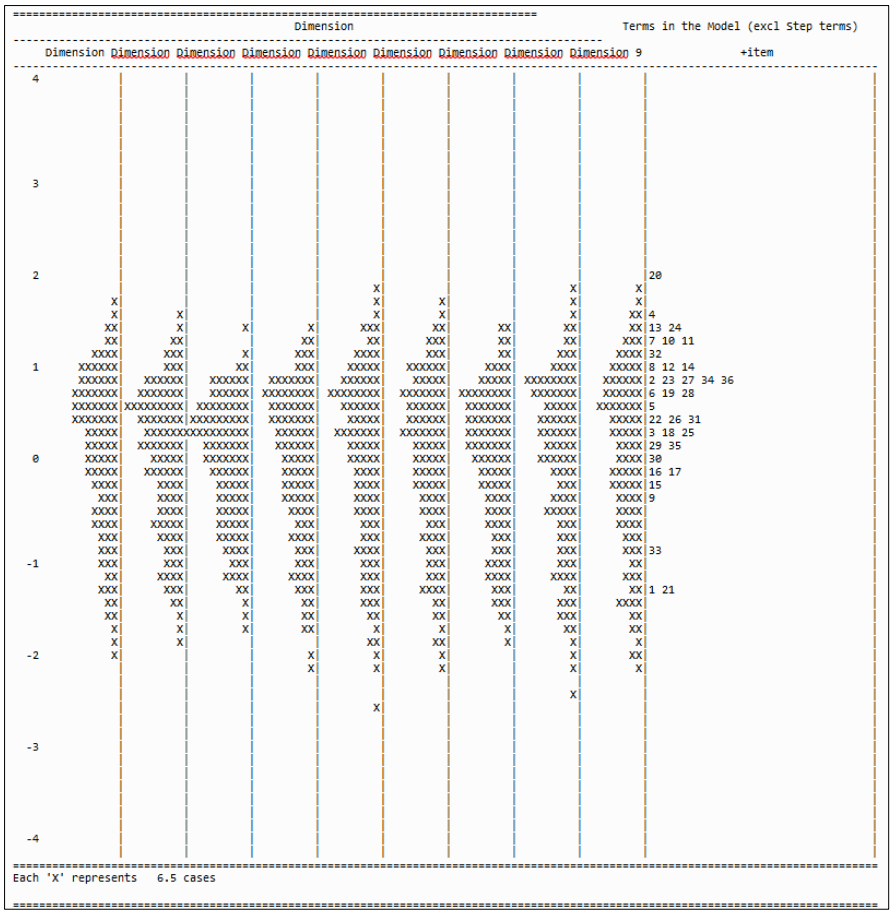

Figure 11. Wright map of the checklist

5-2-6- Results of the Predictive Examination of Key Competencies for Sustainability Transformation using Logistic Regression Analysis

The predictive model of key competencies for transformation toward sustainability on academic achievement is consistent with the empirical data (−2Log Likelihood [−2LL], based model = 933.983, proposed model = 447.947 [Chi-square = 486.036, df = 9, p = 0.000]). The results of the analysis show that there were 7 key competencies for transformation toward sustainability for academic achievement: tolerance for ambiguity (TOA); integrated problem-solving competency (IPS); creating new value (CNV); capacity building competency (CBC); systems-thinking competence (SYC); ability to communicate (ATC); and intrapersonal competence (INC). The two statistically insignificant characteristics were strategic thinking competency (STC) and future thinking competency (FTC). In other words, when aiming to develop competencies for sustainable change that affect academic success, the priorities should be arranged in the following order: tolerance for ambiguity (TOA); integrated problem-solving competencies (IPS), systems thinking competencies (SYC), Ability to Communicate (ATC), capacity building competencies (CBC), Creating New Value (CNV), and intrapersonal competencies (INC). The model predicted academic achievement by 68.50% (Nagelkerke R square = 0.685), as shown in Table 5. Predicting the occurrence of key competencies for transformation toward sustainability to academic achievement and being able to accurately predict academic achievement (79.80%) is presented in Table 6.

Table 5. Logistic regression analysis: A predictive model of key competencies for transforming sustainability to academic achievement

Variable	β	Std. Error	Wald	df	p-value	Exp.(B)
Constant	−22.506	1.720	171.128	1	0.000	0.000
STC	0.094	0.075	1.587	1	0.208	1.099
TOA	0.175	0.074	5.643	1	0.018	1.191
FTC	0.146	0.077	3.599	1	0.058	1.158
IPS	0.312	0.075	17.136	1	0.000	1.366
CNV	0.243	0.067	13.125	1	0.000	1.275
CBC	0.248	0.069	12.769	1	0.000	1.282
SYC	0.311	0.082	14.534	1	0.000	1.365
ATC	0.308	0.069	19.671	1	0.000	1.360
INC	0.223	0.063	12.683	1	0.000	1.250
−2Log Likelihood (−2LL), Based model = 933.983, proposed model = 447.947 (Chi-square = 486.036, df = 9, p = 0.000)						
Hosmer and Lemeshow Test (Chi-square = 106.882, df = 8, p = 0.000)						
Cox & Snell R square = 0.514, Nagelkerke R square = 0.685						

Ability to write logistic regression model equations

$$ln\left(\frac{\pi}{1-\pi}\right) = -22.506 + 0.175\ (TOA) + 0.312\ (IPS) + 0.243\ (CNV) + 0.248\ (CBC) + 0.311\ (SYC) + 0.308\ (ATC) + 0.223(INC) \quad (1)$$

Table 6. Classification results of academic achievement prediction by logistic regression analysis

Academic achievement	Result of prediction		Total
	Low	High	
Low	278	67	80.6
High	69	260	79.0
Percentage accuracy prediction			79.8

6- Discussion

The need to develop a digital assessment system for assessing key competencies for transformation toward sustainability is high, which indicates a great need for digital development because educational assessment in the digital era requires accuracy and speed in processing, as well as systematic reporting. The development of these systems requires the use of modern technology to handle the ever-increasing volume of data and to provide timely data feedback [63]. The need for quality assessment systems is also caused by changes in teaching and learning methods that must be adapted to the use of technology in learning [44]. In addition, digital transformation has made data management and evaluation critical for operational optimization and decision-making. In particular, database

assessment can help make strategic decisions quickly and accurately [64]. In addition, Kitchin [65] stated that big data and open data also play an important role in facilitating digital development and evaluation. In addition, the importance of digital-based assessment is increasing because of the growth of big data and the need to improve assessment processes to make them more efficient and modern. Digital-based assessment systems are also necessary to deal with complex data [66, 67], allowing for accurate data analysis and categorization. Furthermore, fast and secure access to data can help users be confident in terms of the quality and security of the data collected [67]. Currently, there is a need to develop a digital format that can be customized according to specific user requirements, real-time measurement, and reliable reporting [16].

The results of the experiment with regard to the digital-based assessment system, including the results of the assessment of the use of the system by students and of the heuristic assessment and the expert's standard-based assessment, ranged from good to very good. This may be because the digital system was developed with a user-centered design (UCD) [37]. Assessment, design, building, and testing are truly satisfying to students. The system is designed to be easy to use and convenient for users, especially students. The user-conscious design allows the system to satisfy the system requirements and adapt to practical applications. Churchill & Iacobucci [68] and Nicol & Macfarlane-Dick [67] stated that this system can report results quickly. Students can also adapt and improve their skills on the fly. This makes learning a continuous and efficient process. In addition, students can obtain background information quickly. Current developments are increasing toward digital formats, with the goal of enabling assessments to be conducted anywhere and anytime, along with real-time reporting. This is part of effectively promoting United Nations Sustainable Development Goals (SDGs) [14, 15]. It also helps reduce the stress that often arises from traditional exams through flexible assessment formats and engaging interactions. Reduced paper usage in assessment systems can promote sustainability and minimize environmental impact [25]. Furthermore, the use of digital technology in assessment also increases transparency and reliability in measuring learning outcomes [69], which promotes confidence in the education system and in the assessment process [20].

The results of the assessment of all the key competencies for transformation toward sustainability were mostly moderate because the age of adolescent students means that they need to develop mentally and physically. Psychological and social development at this age affects learning ability and performance development in areas that still require constant time and support [70]. In addition, during adolescence, individuals are in the process of building their identities and social skills, which results in many areas of competency remaining moderate and not yet at the highest level [71]. In addition, physical and emotional development is important for future growth and in-depth learning [72]. Another feature may be that all competencies are important for students' development and require continuous attention. It must have been developed at all stages; thus, the performance was at an intermediate level. There is an opportunity for students to evolve at any time in dynamic and ever-changing situations. The development of students' competencies in terms of learning and training must be supported. This will help students strengthen their mental and physical strengths [68].

The key competency for sustainability transformation was multidimensionality. This is because the key competencies for sustainability transformation are characterized by variety and correlation. Key competencies for sustainability transformation require synergy between skills and inclusive development [66]. In addition, the key competencies for sustainability transformation are characterized by various attributes and correlated aspects. These competencies relate not only to technical competence but also to social skills, critical thinking, and an understanding of cultural and environmental contexts [4]. To transform toward sustainability [73], it is necessary to consider the relationship between skills and related values, including the ability to coordinate with others [74]. Furthermore, Basheer et al. [16] found that linking in-depth information across multiple dimensions remains a limitation that needs to be addressed to support development with tangible and sustainable outcomes at all levels. This aligns with the study by Redman & Wiek [6], who developed an integrated framework for multidimensional sustainability education. They synthesized key skills and new competencies that are crucial in guiding sustainability programs toward a broader social impact.

Strategies-thinking competencies (STC) and futures-thinking competencies (FTC) were not predictive of academic achievement, perhaps because strategic and futuristic thinking competencies are important but may not have a direct statistical impact on academic achievement. However, practical achievements may exist, given that strategic thinking and futuristic thinking competencies may be considered very important when preparing for future challenges, although these skills may not directly affect academic achievement in terms of grades or academic performance [75]. This agrees with Rieckmann's concept [76]. However, these skills are essential for adaptability and problem-solving [77]. This is in line with the concept proposed by Inayatullah [78]. Strategic competence and foresight are important for developing the knowledge and skills required in professional life.

7- Conclusion

Personalized assessments, development recommendations for each skill, and multiple assessment evidence are all displayed in real-time through this research invention in the form of a digital assessment system for evaluating key competencies for transformation toward sustainability. The following is a summary of the study findings: 1) To evaluate critical competencies for shift sustainability, students must create a digital assessment system. The system created in this way ensured that everything was of good quality. Experts said that in order to modernize it, a digital-based assessment system that is quick, easy, affordable, and efficient had to be developed. 2) The system for digital assessment was created. The website provides a real-time, individualized evaluation with three levels of results (low, medium, and high) and recommendations for individual students regarding the development of each competency. In terms of the results of individual assessments in the administrative sector, in the trial with the digital-based assessment system, the dependability scores of the situational and checklist versions were found to be 0.76 and 0.86, respectively. In terms of the evaluation findings, the digital-based assessment system's screen, terminology, system information, and system capabilities were all found to be at a good level.

The expert evaluation results indicated that overall, the heuristic was at a good level (reliability = 0.79), and standards-based evaluation revealed that its utility, interpretation, and accuracy were all very good (reliability = 0.86, 0.79, and 0.92, respectively). 3) The situational and checklist versions' student assessment reliability were 0.80 and 0.84, respectively. According to the assessment findings, the digital-based assessment system's screen, terminology, system information, and system capabilities were all found to be at a good level. According to the multidimensional analysis, the Infit and Outfit had the correct values, and multidimensionality was observed in the evidence of key competencies for transformation toward sustainability. In addition, 7 competencies could be predicted, but 2 could not, according to the prediction model of key competencies for transformation toward sustainability to academic achievement. The logistic regression analysis supported this condition. Academic achievement can be predicted by the model (68.50%), and it can do so with 79.80% accuracy. The practical significance of this research is its use of a digital assessment system for assessing key competencies for transformation toward sustainability that can be assessed anytime and anywhere, with the results of individual assessments displayed instantly and supported by development guidelines. Therefore, students can immediately improve their competencies.

7-1- Suggestions for Implementation

- The Office of the Vocational Education Commission should establish policies to develop essential competencies for sustainable change in the form of soft skills that should be promoted in each vocational education curriculum.
- Teachers or stakeholders should implement a digital-based assessment system for assessing key competencies for transformation toward sustainability to assess students anytime, anywhere, and immediately. They should be prepared to apply development guidelines to promote student development.
- Age is a factor related to key competencies for sustainability transformation. Therefore, the assessment system must be used for the appropriate age range, namely 16–19 years, to ensure that it is suitable for the assessment and development of key competencies.
- Because the results of all competency assessments are moderate, developing key competencies for transformation toward sustainability in all competencies is necessary by using the development approach in the assessment system as a stimulus for students' self-development. For teachers, activities should be strengthened to instill in students, and administrators should formulate development guidelines in the form of action plans.
- Key competencies for transforming sustainability in student assessment are multidimensional. Therefore, assessment applications must take into account the characteristics of multidimensionality involving both between- and within-item multidimensionality. This will make the assessment accurate according to the structure.
- If there is an assessment of key competencies for transformation toward sustainability, priority weighting and scoring should be determined according to the logistical regression coefficients as follows: tolerance for ambiguity (TOA), internal competencies (INC), new value creation (CNV), competency building (CBC), communication competency (ATC), systems thinking competency (SYC), integrated problem-solving competency (IPS), future thinking competency (FTC), and strategic thinking competency (STC).

7-2- Suggestions for Future Research

- Evidence of key competencies for sustainability transformation should be developed using second- and third-order factor analyses.
- The key competencies for transformation toward sustainability that have been applied should be applied to the design of model changes in the form of theoretical changes that may come from the theory of assumptions or hypothetical relationships, or design notational changes.

- Education develops key competencies for transformation toward sustainability. If it is to be developed, the first order should be tolerance for ambiguity because it has the most weight. It can be developed in the form of research and development or design research.
- In each of the key competencies for transformation toward sustainability, it is important to research the causes that affect competency. The research could take the form of mixed-methods research.
- Research and develop in-depth strategies-thinking competencies (STC) and futures-thinking competencies (FTC) of vocational students. This can be done through qualitative research for research and development purposes.

8- Declarations

8-1- Author Contributions

Conceptualization: C.C.; methodology: C.C.; software: C.C.; validation: C.C.; formal analysis: C.C. and S.N.W.; investigation, C.C. and S.N.W.; resources, C.C. and S.N.W.; data curation, C.C.; writing—original draft preparation, C.C.; writing—review and editing, C.C.; visualization, C.C. and S.N.W.; supervision, C.C. and S.N.W.; project administration, C.C.; funding acquisition, C.C. and S.N.W. All authors have read and agreed to the publication of the finale version of the manuscript.

8-2- Data Availability Statement

The data presented in this study are included in the article.

8-3- Funding

This research was funded by King Mongkut's University of Technology North Bangkok, Contract no. KMUTNB-67-BASIC-03.

8-4- Ethical Approval

Ethics regarding human subject research in the social sciences are upheld in this study. This study was approved by the Ethics Committee of Naresuan University (No. 0063/2023).

8-5- Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

8-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

9- References

[1] Prayurasak, P. (2012). Recruitment and Staffing. In The Encyclopedia of Human Resource Management. Media Center and Graph Publication Fix, John Wiley & Sons, New Jersey, United States. doi:10.1002/9781118364727.part1.

[2] Vathanophas, V. (2006). Competency Requirements for Effective Job Performance in Thai Public Sector. Contemporary Management Research, 3(1), 45. doi:10.7903/cmr.49.

[3] Illeris, K. (2012). International perspectives on competence development: Developing skills and capabilities. International Perspectives on Competence Development: Developing Skills and Capabilities, 1(1), 1–228. doi:10.4324/9780203523032.

[4] Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key competencies in sustainability: A reference framework for academic program development. Sustainability Science, 6(2), 203–218. doi:10.1007/s11625-011-0132-6.

[5] Yu, M., Wang, H., & Xia, G. (2022). The Review on the Role of Ambiguity of Tolerance and Resilience on Students' Engagement. Frontiers in Psychology, 12, 828894. doi:10.3389/fpsyg.2021.828894.

[6] Redman, A., & Wiek, A. (2021). Competencies for Advancing Transformations towards Sustainability. Frontiers in Education, 6, 1–11. doi:10.3389/feduc.2021.785163.

[7] Rusyati, L., Rustaman, N. Y., Widodo, A., & Ha, M. (2021). Development of questionnaire instrument to assess students' transformative competencies in science learning. Journal of Physics: Conference Series, 2098(1), 012035. doi:10.1088/1742-6596/2098/1/012035.

[8] Venn, R., Perez, P., & Vandenbussche, V. (2022). Competencies of Sustainability Professionals: An Empirical Study on Key Competencies for Sustainability. Sustainability (Switzerland), 14(9), 1–22. doi:10.3390/su14094916.

[9] Laudon, K. C., & Laudon, J. P. (2004). Management information systems: Managing the digital firm. Pearson Education, London, United Kingdom.

[10] Eberz, S., Lang, S., Breitenmoser, P., & Niebert, K. (2023). Taking the Lead into Sustainability: Decision Makers' Competencies for a Greener Future. Sustainability (Switzerland), 15(6), 4986. doi:10.3390/su15064986.

[11] Valdes-Ramirez, D., de Armas Jacomino, L., Monroy, R., & Zavala, G. (2024). Assessing sustainability competencies in contemporary STEM higher education: a data-driven analysis at Tecnologico de Monterrey. Frontiers in Education, 9. doi:10.3389/feduc.2024.1415755.

[12] Zervas, I., & Stiakakis, E. (2024). Economic Sustainable Development through Digital Skills Acquisition: The Role of Human Resource Leadership. Sustainability, 16(17), 7664. doi:10.3390/su16177664.

[13] UNESCO. (2023). Digital Competencies and Skills. UNESCO, Paris, France. Available online: https://www.unesco.org/en/digital-competencies-skills (accessed on March 2025).

[14] Hajj-Hassan, M., Chaker, R., & Cederqvist, A. M. (2024). Environmental Education: A Systematic Review on the Use of Digital Tools for Fostering Sustainability Awareness. Sustainability (Switzerland), 16(9), 3733. doi:10.3390/su16093733.

[15] Valdes-Ramirez, D., de Armas Jacomino, L., Monroy, R., & Zavala, G. (2024). Assessing sustainability competencies in contemporary STEM higher education: a data-driven analysis at Tecnologico de Monterrey. Frontiers in Education, 9. doi:10.3389/feduc.2024.1415755.

[16] Basheer, N., Ahmed, V., Bahroun, Z., & Anane, C. (2024). Exploring Sustainability Assessment Practices in Higher Education: A Comprehensive Review through Content and Bibliometric Analyses. Sustainability (Switzerland), 16(13), 5799. doi:10.3390/su16135799.

[17] Redecker, C., & Johannessen, Ø. (2013). Changing Assessment - Towards a New Assessment Paradigm Using ICT. European Journal of Education, 48(1), 79–96. doi:10.1111/ejed.12018.

[18] Keengwe, J. (2022). Handbook of research on digital-based assessment and innovative practices in education. IGI Global, Pennsylvania, United States.

[19] Crisp, G. (2011). Teacher's Handbook on e-Assessment. Transforming Assessment-An ALTC Fellowship Activity, 18.

[20] Bennett, R. E. (2011). Formative assessment: A critical review. Assessment in Education: Principles, Policy & Practice, 18(1), 5–25. doi:10.1080/0969594X.2010.513678.

[21] Redecker, C. (2013). The use of ICT for the assessment of key competences. Publications Office of the European Union. Brussels, Belgium.

[22] Bennett, R. E. (2015). The Changing Nature of Educational Assessment. Review of Research in Education, 39(1), 370–407. doi:10.3102/0091732X14554179.

[23] NAEP. (2024). Transitioning to Digitally Based Assessments. National Center for Education Statistics (NAEP), Washington, United States. Available online: https://nces.ed.gov/nationsreportcard/dba/ (accessed on March 2025).

[24] Henebery, B. (2024). What should student assessment look like in 2024?. The Educator, Sydney, Australia. Available online: https://www.theeducatoronline.com/k12/news/what-should-student-assessment-look-like-in-2024/284044 (accessed on March 2025).

[25] MagicBox. (2024). Digital Assessment: Putting Students First in Testing and Evaluation. MagicBox, Barcelona, Spain. Available online: https://www.getmagicbox.com/blog/digital-assessments-putting-students-first-in-testing-and-evaluation/ (accessed on March 2025).

[26] Bowden, J. (2024). Online Assessment and Digital Exams: What's it all about and the Benefits? Inspera, Oslo, Norway. Available online: https://www.inspera.com/online-assessments/digital-and-online-assessment-benefits/ (accessed on March 2025).

[27] Times Higher Education. (2024). The importance of digital assessment for a successful blended learning strategy. Times Higher Education, London, United Kingdom. Available online: https://www.timeshighereducation.com/hub/inspera/p/importance-digital-assessment-successful-blended-learning-strategy (accessed on March 2025).

[28] Slade, C., Mahon, K., Benson, K., Lynagh, J., McGrath, D., Sheppard, K., & Ahsan, Q. (2024). A pedagogical evaluation of an institution's digital assessment platform (DAP): Integrating pedagogical, technical and contextual factors. Australasian Journal of Educational Technology, 40(4), 90–104. doi:10.14742/ajet.9448.

[29] Pachler, N., Daly, C., Mor, Y., & Mellar, H. (2010). Formative e-assessment: Practitioner cases. Computers and Education, 54(3), 715–721. doi:10.1016/j.compedu.2009.09.032.

[30] McFarlane, A. (2003). Editorial. Assessment for the digital age. Assessment in Education: Principles, Policy & Practice, 10(3), 261–266. doi:10.1080/0969594032000148127.

[31] Bennett, R. E. (2005). Inexorable and Inevitable: The Continuing Story of Technology and Assessment. Computer- Based Testing and the Internet, 201–217, John Wiley & Sons, Hoboken, United States. doi:10.1002/9780470712993.ch11.

[32] Bull, J., & McKenna, C. (2003). A Blueprint for Computer-Assisted Assessment. Routledge, Milton Park, United Kingdom. doi:10.4324/9780203464687.

[33] Whitelock, D. (2009). Editorial: e-assessment: developing new dialogues for the digital age. British Journal of Educational Technology, 40(2), 199–202. doi:10.1111/j.1467-8535.2008.00932.x.

[34] Bennett, R. E. (2001). How the Internet Will Help Large-Scale Assessment Reinvent Itself. Education Policy Analysis Archives, 9, 5. doi:10.14507/epaa.v9n5.2001.

[35] Scalise, K., & Gifford, B. (2006). Computer-based assessment in E-learning: A framework for constructing "intermediate constraint" questions and tasks for technology platforms. Journal of Technology, Learning, and Assessment, 4(6), 3–44.

[36] Kendall, K. E., & Kendall, J. E. (2014). Systems analysis and design. Pearson, London, United Kingdom.

[37] Lior, L. N. (2013). Evaluating Your Information Experience. Writing for Interaction, 241–261, Morgan Kaufmann, Burlington, United States. doi:10.1016/b978-0-12-394813-7.00012-2.

[38] Sadler, D. R. (1989). Formative assessment and the design of instructional systems. Instructional Science, 18(2), 119–144. doi:10.1007/BF00117714.

[39] Dochy, F. J. R. C., & McDowell, L. (1997). Assessment as a tool for learning. Studies in Educational Evaluation, 23(4), 279–298. doi:10.1016/s0191-491x(97)86211-6.

[40] Torrance, H. (2012). Formative assessment at the crossroads: Conformative, deformative and transformative assessment. Oxford Review of Education, 38(3), 323–342. doi:10.1080/03054985.2012.689693.

[41] Harlen, W. (2007). The Quality of Learning: assessment alternatives for primary education. The Cambridge Primary Review Research Surveys, 504–540. doi:10.4324/9780203121672-31

[42] Taras, M. (2005). Assessment - Summative and formative - Some theoretical reflections. British Journal of Educational Studies, 53(4), 466–478. doi:10.1111/j.1467-8527.2005.00307.x.

[43] Shannaq, B. (2025). E-Learning Integration and Its Impact on MIS Skill Development and Student Engagement. Emerging Science Journal, 8, 425-443. doi:10.28991/ESJ-2024-SIED1-025.

[44] Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. Educational Assessment, Evaluation and Accountability, 21(1), 5–31. doi:10.1007/s11092-008-9068-5.

[45] Boud, D., & Falchikov, N. (2006). Aligning assessment with long-term learning. Assessment & Evaluation in Higher Education, 31(4), 399–413. doi:10.1080/02602930600679050.

[46] Chianchana, C. (2022). Development of an Educational Sustainability Assessment Model: Application of the Delphi Technique and Pilot Study. Journal of Education and E-Learning Research, 9(2), 119–128. doi:10.20448/jeelr.v9i2.4044.

[47] Sabino, A., Moreira, A., Cesário, F., & Coelho, M. P. (2024). Measuring Sustainability: A Validation Study of a Triple Bottom Line (TBL) Scale in Portugal. Emerging Science Journal, 8(3), 899–916. doi:10.28991/ESJ-2024-08-03-06.

[48] Dix, A., Finlay, J., Abowd, G., & Beale, R. (2004). Human-computer Interaction. Prentice Hall, London, United Kingdom.

[49] Galitz, W. O. (2007). The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques, John Wiley & Sons, Hoboken, United States.

[50] Preece, J., Rogers, Y., & Sharp, H. (2015). Interaction design: Beyond human-computer interaction. (4th Ed.). John Wiley & Sons, Hoboken, United States.

[51] Nielsen, J. (1994). Heuristic Evaluation. Usability Inspection Methods, 25-62. John Wiley & Sons, Hoboken, United States.

[52] Fitzpatrick, J. L., Sanders, J. R., & Worthen, B. R. (2011). Program Evaluation: Alternative Approaches and Practical Guidelines (4th Ed.). Pearson, London, United Kingdom.

[53] Patton, M. Q. (2008). Utilization-focused Evaluation (4th Ed.), Sage Publications, Thousand Oaks, United States.

[54] Stiggins, R. J. (2001). Student-involved classroom assessment (3rd Ed.). Prentice Hall, Saddle River, United States.

[55] Kanjanawasee, S., Pitayanon, T., & Srisukho, D. (2008). Select appropriate statistics for research (5th Ed.). Cuprina, Bangkok, Thailand.

[56] Patton, M.Q. (2002). Qualitative Evaluation and Research Methods (3rd Ed.), Sage Publications, Thousand Oaks, United States.

[57] Johanson, G. A., & Brooks, G. P. (2009). Initial Scale Development: Sample Size for Pilot Studies. Educational and Psychological Measurement, 70(3), 394–400. doi:10.1177/0013164409355692.

[58] Embretson, S. E., & Reise, S. P. (2013). Item Response Theory. Psychology Press, London, United Kingdom. doi:10.4324/9781410605269.

[59] Tabachnick, B. G., & Fidell, L. S. (2007). Multivariate Statistics (5th Ed.). Pearson Education, London, United Kingdom.

[60] Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). Multivariate Data Analysis (6th Ed.), Pearson Prentice Hall, Saddle River, United States.

[61] Adams, R. J., Wilson, M., & Wang, W. C. (1997). The multidimensional random coefficients multinomial logit model. Applied Psychological Measurement, 21(1), 1–23. doi:10.1177/0146621697211001.

[62] Allen, D. D., & Wilson, M. (2006). Introducing multidimensional item response modeling in health behavior and health education research, Health Education Research Theory & Practice, 21(Supplement 1), 73-84.

[63] Boud, D., & Molloy, E. (Eds.). (2012). Feedback in Higher and Professional Education. Routledge, London, United Kingdom. doi:10.4324/9780203074336.

[64] Davenport, T. H., & Harris, J. G. (2017). Competing in Analytics: The New Science of Winning, Harvard Business Press, Brighton, United States.

[65] Kitchin, R. (2014). The Data Revolution: Big Data, Open Data, Data Infrastructures & Their Consequences. Sage Publications, Thousand Oaks, United States. doi:10.4135/9781473909472.

[66] Bartholomew, D. J., Steele, F., Galbraith, J., & Moustaki, I. (2008). Analysis of Multivariate Social Science Data. Chapman & Hall, New York, United States. doi:10.1201/b15114.

[67] Nicol, D., & MacFarlane-Dick, D. (2006). Formative assessment and selfregulated learning: A model and seven principles of good feedback practice. Studies in Higher Education, 31(2), 199–218. doi:10.1080/03075070600572090.

[68] Churchill, G. A., & Iacobucci, D. (2006). Marketing research: methodological foundations. Dryden Press, Hinsdale, United States.

[69] Shute, V. J. (2008). Focus on formative feedback. Review of Educational Research, 78(1), 153–189. doi:10.3102/0034654307313795.

[70] Steinberg, L. (2014). Age of Opportunity: Lessons Learned from the New Science of Adolescence, Harper Paperbacks, New York, United States.

[71] Erikson, E. H. (1968). Identity youth and crisis. WW Norton & company, New York, United States.

[72] Lerner, R. M., & Steinberg, L. (Eds.). (2009). Handbook of Adolescent Psychology. John Wiley & Sons, Hoboken, United States. doi:10.1002/9780470479193.

[73] Sterling, S. (2011). Transformative learning and sustainability: Sketching the conceptual ground. Learning and teaching in higher education, 5(11), 17-33.

[74] Barth, M., Godemann, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing key competencies for sustainable development in higher education. International Journal of Sustainability in Higher Education, 8(4), 416–430. doi:10.1108/14676370710823582.

[75] Godet, M. (2006). Creating futures: Scenario planning as a strategic management tool. The Brookings Institutions, Washington, United States.

[76] Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? Futures, 44(2), 127–135. doi:10.1016/j.futures.2011.09.005.

[77] Van der Heijden, K. (2005). Scenarios: the art of strategic conversation. John Wiley & Sons, Hoboken, United States.

[78] Inayatullah, S. (2008). Six pillars: Futures thinking for transforming. Foresight, 10(1), 4–21. doi:10.1108/14636680810855991.

Appendix I

ASK-CTS

Situation test (example)

Statement: Select only one answer that is most true.

1- If students receive an evaluation from teachers to develop and improve themselves, which of the following should they do the most?

1) I will gradually improve it when I have free time.
2) The evaluation results were used to consider areas that needed improvement.
3) Consider and choose appropriate methods of self-development.

2- If students have to present their work in front of the class for their friends to listen to, which of the following should they design their presentation to?

1) Data is collected by searching online.
2) Ask your friends how to present it.
3) Conduct a comprehensive analysis of the presentation perspectives.

3- If a student is selected to represent the college in a team sports competition, which of the following should be done most often?

1) Study the training plan
2) Build relationships within the team
3) Analyze the strengths and weaknesses of your own team and your competitors.

4- If students wish to apply to be selected as student representatives of the college, which of the following should they most likely do?

1) Invite and recruit the team to apply for selection
2) Create public relations images in the form of posters and online, and meet and campaign with friends and juniors.
3) Election campaigns to demonstrate a clear vision and direction for the work.

5- If students encounter new events or situations that they have never encountered before, which of the following actions would they most likely follow?

1) Still not sure about facing new things
2) Dare to face new things by yourself.
3) Invite your friends to experience new things together

6- If students need to find information from social media, which of the following should they do the most?

1) Believe in the news your friends tell you.
2) Trust popular social media
3) Read a variety of social media to find factual information.

7- If a student is a member of a group and a conflict of ideas arises within the group, which of the following should be done most often?

1) Let the group leader decide the issue.
2) It is proposed that the meeting be rescheduled on another day to improve the atmosphere.
3) Participate in resolving conflicts with your group members until a common solution is reached.

8- If students are assigned to study and research information and find that the information they study is still unclear, which of the following should they do?

1) Wait for your friends to help share information.
2) Avoid ambiguous information.
3) Research methods to obtain clear information.

9- If students are assigned to study the impacts that will follow from the global warming phenomenon, which of the following will they most likely do?

1) Find information on the global warming phenomenon

2) Analyze data and create models to predict what will happen.

3) Use the obtained data to analyze the global warming phenomenon from various perspectives.

10- If students are assigned to study and research methods to develop a college to be a livable place in the 21st century, which of the following should they most likely do?

1) Consider your favorite college model

2) Wait for information from friends and then think of ways to develop.

3) Research multiple sources of information and develop guidelines for college development.

11- If students were given the task of analyzing their future careers, which of the following would they most likely do?

1) Take up a popular career

2) Career analysis based on friends

3) Consider the possibilities of a career that is suitable for you.

12- If students are assigned to research the issue of children being addicted to games, which of the following should they most likely do?

1) Analyzing the causes of children becoming addicted to games

2) Research information on children addicted to games

3) Predicting the future consequences of children becoming addicted to games

13- If a student has a problem with low academic performance, which is caused by family and bullying by friends, which of the following should be done most often?

1) It is expected that the next semester will be better.

2) Read more books and review your lessons.

3) Consult people around you to find ways to solve the problem of poor academic performance.

14- If students have problems adjusting to their friends in the classroom, which of the following should they do most often?

1) Research adaptation data

2) Try making friends in other classes so you'll have less time to adjust.

3) Consult with teachers and parents and be ready to adapt.

15- If students have financial problems and do not have enough money to spend during their studies, which of the following should they do most?

1) Earn extra income

2) Reduce expenses and earn extra income outside of school hours

3) Reduce food consumption by focusing on eating more instant noodles.

16- If a student is assigned to do a project at the end of the semester and finds out that the project may not be completed on time, which of the following should be done?

1) Request to postpone the submission of the work

2) Allocate more time to work on the project to deliver it on time.

3) Analyze the past to find any shortcomings and adjust the working method to deliver the work on time.

17- If students are assigned by a teacher to make use of leftover wood scraps, which of the following should they do the most?

1) Used for making fires
2) Made into a table lamp
3) Made into a sailboat and kept in a display case.

18- If students are assigned by teachers to interview community leaders who are role models or idols for students to develop their own communities, which of the following should be done most often?

1) One interview with a community leader is enough.
2) Studying the history of existing community leaders should be sufficient.
3) Interview community leaders multiple times to obtain in-depth information.

19- If a student has to submit a project to a teacher in a subject, which of the following should be done most often?

1) Modify the original project slightly to meet the deadline.
2) Create a unique project that does not duplicate past projects.
3) Use exemplary projects as models for project implementation.

20- If a student is assigned to make a singing video and send it to the teacher, which of the following should be done most often?

1) Based on the original song
2) Re-arrange the melody from the original song.
3) Experiment with mixing in other types of music and singing in your own style.

21- If a student is appointed as a team leader who must make team members have the energy to work, which of the following should be done the most?

1) Give work according to each person's ability.
2) Give team members opportunities to express their opinions and have their opinions heard.
3) Train all members to focus on the team's goals, with the team leader being a good role model for the group.

22- If a student is assigned to motivate his/her classmates to work, which of the following actions will he/she most likely follow?

1) Let each person express their feelings about their work.
2) Try to find role models who are good examples for your friends to follow.
3) Help your team members clearly see their work goals and take action to achieve them.

23- If a student is assigned to be a team leader in a group project, which is an extracurricular project where the team members must complete the work within a specified time, which of the following should be done most often?

1) Let each person work and then consider the results.
2) Let each group member accelerate their work to achieve their set goals.
3) Create excitement at work by rewarding colleagues who complete assigned tasks first and with quality.

24- The teacher assigns students to work in groups, in which each person has the duty to produce their own work to be combined into a group project. However, some of them do not complete their work and do not finish it on time, causing the group work to be incomplete. If students are assigned to evaluate the work of other groups, which of the following should they do the most?

1) Consider the group work as a whole, giving everyone in the group the same score.
2) Consider only the individual's work, and give different scores to each person.
3) Each individual's work is graded differently, but group work is graded equally.

25- If you receive information that a student from one college likes to eat fish, exercises, and eats vegetables and fruits to have good physical health, but a student from another college also likes to eat fish, exercises, but is not very healthy, if the student has to summarize the information, which of the following would you most likely do?

1) In summary, from the available data, good and bad health are determined by the individual.

2) To summarize honestly, do more research to come to the right conclusion.

3) Summarize logically, find out more, and connect the factors that make you healthy and unhealthy.

26- There are many problems of ecological degradation at present, such as global warming, climate change, and reduced food sources. Which of the following do students think is the most likely solution to these problems?

1) Throw away trash properly

2) Help preserve the environment

3) Improve the quality of all environmental systems.

27- "The sports training system of a college consists of 1) Input factors: competition equipment and the athlete's body. 2) Process: 6 training activities, averaging 270 minutes/week. 3) Outcome: athletes are physically, mentally, and emotionally ready to compete and have techniques for competing in sports. 4) Evaluation: evaluating input factors, processes, and outcomes." If the average practice time is 250 minutes/week, which of the following do you think will cause problems in this system and how will you solve the problem?

1) There is a problem in the input part. Solve the problem in the process part.

2) Problems in the process section, fix problems in the process section and evaluation.

3) Problems occurred in the input and process areas. Problems were resolved in the process areas.

28- "Students have chosen to use the 4-step system of planning-implementation-checking-improvement to use in evaluating their own learning if the students can do the following: 1) set goals for what to improve; 2) evaluation results show that past actions did not achieve goals; 3) take action to achieve goals." What is the thing that students have not done according to the system they are using?

1) amend

2) Plan to improve

3) Plan, check, improve

29- If a teacher assigns students to summarize the content they have learned and wants to communicate it in a social media format that allows them to post messages, various types of clips, send pictures, and make phone calls, which of the following media will students choose to use the most?

1) Line, phone, email

2) YouTube Instagram Facebook

3) Line Facebook Instagram

30- A study from a journal found that the factor that makes students learn well is their mental abilities, which can be predicted up to 75 percent. If students have to interpret the meaning of data, which of the following would they choose the most?

1) Brain abilities can predict students' learning.

2) The factor that makes students learn well is their brain abilities.

3) Brain abilities affect learning, are highly predictable, and should be developed for students.

31- If a student were to provide feedback to a classmate about a piece of writing submitted to the teacher, which of the following would be most helpful?

1) Well written, but some are not so good.

2) Two points are well written and one point is not well written.

3) It is well written because it meets the objectives, and some parts are poorly written because there is insufficient information.

32- If a friend who is not close to you talks about the dress of students, saying that they sometimes dress inappropriately and inappropriately, which of the following should the student do the most?

1) Listen to your friends so that there will be no problems.

2) Keep this information for consideration.

3) Since we are not close friends, it's okay to not listen.

33- If a student is selected to be a representative athlete of the college, which will compete in the next two weeks, which of the following should the student do the most?

1) Eat healthy, exercise regularly, and practice sports skills because that's what people have been following.

2) Eat healthy, exercise regularly, and practice your sports skills so that you have a better chance of winning when competing.

3) Eat healthy food, exercise regularly, practice sports skills, and train your mind to make your body, playing skills, and mind ready for competition.

34- If a student has work to do and submit to the teacher tomorrow morning, and a friend invites him to play sports first and then come back to continue working, the student agrees to play sports with his friends. However, when he goes to play, he has fun. If he continues to play, he will definitely not have enough time to work. Which of the following should the student do the most?

1) Continue playing sports because it is fun.

2) Tell your friend that you are going back to work so that the work can be completed.

3) Continue playing sports a little more when you feel comfortable and believe that the work you do will be successful.

35- In a class of a subject, the teacher assigned each student to write down life goals such as career, education, health in order to be in line with the rapidly changing world. Which of the following would the student most likely do?

1) Write what your parents agree to.

2) Write in a similar way to your friends.

3) Write what you want and what is possible.

36- In the final exam of the semester, students have enough time to prepare, but they become careless and do not have enough time to study. This results in a poor result in one subject, which is not as good as they expected. Which of the following should the students do the most?

1) Get ready to read the book in time.

2) Let time pass first. When you feel comfortable, reading should be in time.

3) Explain to your friends and teachers the reasons for your results.

Checklist (Example)

Statement: Let the students select items by marking the boxes, no more than 4 items per question, that must be completed according to each given question.

1. A list of things to do to develop the ability of individuals to think conceptually, systematically and imaginatively and bring opportunities to create success...

- Create an action plan
- Facing new situations
- Have your own broad perspective
- Recognize uncertainty
- Analyze competitive advantages
- Facing conflicting issues
- Connect to the vision
- Ready to deal with ambiguous information

2. A list of things to do to develop the ability to endure things ...

- Create models to predict what will happen
- Facing new situations
- Forecast for future development
- Recognize uncertainty
- Understanding the possibilities and probabilities
- Facing conflicting issues
- Analyze and evaluate what will happen in the future
- Ready to deal with ambiguous information

3. A list of things that must be done to develop the ability to think imaginatively...

- Create models to predict what will happen
- Create something new and valuable
- Forecast for future development
- Use insights to drive development actions
- Think of new techniques and solutions.
- Understanding the possibilities and probabilities
- Think outside the box at work
- Analyze and evaluate what will happen in the future

4. List of actions that need to be taken to jointly solve the problems that have occurred...

- Create models to predict what will happen
- Understanding the possibilities and probabilities
- Forecast for future development
- Analyze and evaluate what will happen in the future
- Develop potential problem-solving options
- Use problem-solving processes to solve complex problems.
- Integrating problem analysis with assessment and strategy generation
- Developing integrated work

5. A list of actions to be taken to create new values ...

- Use problem-solving processes to solve complex problems.
- Create something new and valuable
- Developing integrated work
- Use insights to drive development actions
- Think of new techniques and solutions.
- Develop potential problem-solving options
- Think outside the box at work
- Integrating problem analysis with assessment and strategy generation

6. A list of actions to be taken to strengthen the potential of people around you ...

- Create motivation by being a good role model
- Take care of yourself
- Inspire others
- Self-control
- Get others excited
- Set life goals
- Make the group feel a sense of shared ownership and responsibility.
- Be responsible for yourself

7. List of actions to be taken to think systematically...

- Use problem-solving processes to solve complex problems.
- Connecting information available in wider society
- Developing integrated work
- Analyze the dynamics of social ecosystems
- Develop potential problem-solving options
- Analysis of system changes and problems
- Integrating problem analysis with assessment and strategy generation
- Analyze and understand the system

8. List of things to do in communication...

- Connecting information available in wider society
- Provide constructive feedback to others.
- Analyze the dynamics of social ecosystems
- Learn to listen to feedback from other people.
- Convey messages through clear media.
- Analysis of system changes and problems
- Receive and interpret data
- Analyze and understand the system

9. List of actions to be performed to demonstrate personal abilities...

- Take care of yourself
- Create motivation by being a good role model
- Self-control
- Inspire others
- Set life goals
- Get others excited
- Be responsible for yourself
- Make the group feel a sense of shared ownership and responsibility.