

Computer-Based Checker for Technical Drafting Plates: Development and Evaluation

Reinze L. Vito

reinze.vito@gmail.com

Congressional National High School, Dasmarias City, Cavite, Philippines

Gemma D. Belga

gdbelga@gmail.com

Technological University of the Philippines, Manila, Philippines

Myrna R. Batino

mrbatino2012@gmail.com

Technological University of the Philippines, Cavite, Philippines

Abstract

The Computer-based Checker for Technical Drafting plates (CCTDp) was developed to assist the faculty and the students in senior high school to an objective, reliable and timely assessment of technical drawings under the five CAD competencies of Department of Education. The LAN-based computer system includes features such as submission of technical drafting plates and deployment of scores and feedbacks. There are two (2) accounts developed for the checking software: the faculty and the students' account used to access CSTDp. The scoring and feedback is based upon a TESDA TEC NC II assessors' validated scoring criteria which covers line technique, accuracy and completeness, annotations, plotting and speed. It was also evaluated using ISO 25010 by IT practitioners, TEC NC II assessors, teachers and SHS students. Grand mean score of 4.80 interpreted as "outstanding" was achieved by the system which denotes that CSTDp is an effective and efficient computer-based system. It also implies that the developed system facilitates immediate provision of scores and feedback to the learners while employing the 21st century teaching strategies inside the classroom. The developed software also addressed the accuracy, reliability and the timeliness of assessment for the performance-based assessment in technical drafting.

Keywords: computer-based, checker, technical drafting, technical drawing

INTRODUCTION

In this globally and digitally interconnected world, all learners are given opportunities to learn 21st century skills in preparation for their success in school, work, and life. To act alongside this vision, performance-based assessment is applied as it is recognized to be one of the best assessment techniques in measuring the progress of 21st century skills yet a complex assessment procedure for the assessors. Few factors most often distinguished as barriers on carrying out this assessment practice are lack of time, resources, and infrastructure (Tuckwiller, 2012). These barriers cause teachers to disregard this type of assessment due to its strenuous requirements on standardization of scoring procedures, especially to complex performance tasks (Rosaroso & Rosaroso, 2015). Zhang (2013) also regarded its existence of human error due to cognitive limitations which can be difficult or even impossible to quantify. As giving of feedback "contributes directly to progress in learning through the process of formative assessment, and indirectly through its effect on pupils' academic self-esteem," it is likewise perceived to be potential adversity considering that it is an arduous task that must be administered within a short timeframe (Obaid, 2014).

On the grounds of difficulties experienced by the faculty on the implementation of various types of assessment, technology advancement and innovation in the field of assessment in education was motivated. ZipGrade, for example, is a mobile application used for grading multiple-choice assessments thru turning the mobile device into an optical scanning machine and draw feedback in an instance. Similarly, Paper rater uses artificial intelligence and data science to detect grammar, punctuation and spelling errors; and advice on writing essays (Paper Rater, 2018). Great

impact was perceived from these applications because it expedites scores, quantity and quality of feedback, and its response time. However, more than multiple choice and essay type of assessment, many of today's emerging curricula require a different type and aid for its assessment processes.

In California, Introduction of Computer-Aided Design (CIV_E121_CX) is a course in Civil Engineering where students are asked to draw primitive entities such as lines, polylines, circles, arcs, and text as the foundation for more complex engineering drawings. The manual checking of these drawings is tedious and time-consuming as the grader has to check each and every primitive entity, possibly causing small errors to be neglected or skipped. The dilemma moved Deo (2010) in the development of a back-end component of an AutoCAD grading application which compares student's drawing to a reference drawing and generates feedback after the completion of each exercises. Moreover, an enhancement effort for the same research project was then conducted by Karna (2012) through remodeling the system into an end-to-end web-based approach from its desktop application version with an improved graphical user interface. The projects were purposely developed only for university use where the study found recommendations for improvements that are to be addressed. Its scoring capability is strictly point-to-point and the timeframe for completion and matching of submitted exercises on the quality and expected standards are unclear. The general grading criteria as well use the number of entities, their values, and the measurements to be checked instead of criteria usually applied by a professor. Hence, a contextualized and improved version of the program is a must to be developed to suffice the emerging needs of today's education.

In the Philippines, Technical Drafting is a specialization under Technical Vocational and Livelihood (TVL) track in the K to 12 curriculum which target students' acquisition of competencies in preparing computer-aided drawings using AutoCAD software. Students are expected to create technical drawings as individual output to obtain the required competencies. On the other hand, the teacher then will manually assess, evaluate, and record students' performance in an objective, just, and timely manner. Manual checking of these technical drawings leads the instructor into an arduous task given the number of students and activities to be checked. It also springs to shortcomings such as delay in grading, errors in the evaluation, time-consuming, and improper utilization of resources. All of these can only be addressed through further development of projects that will lead resolution to the demands of both teachers and students. In the absence of available system to cater to these challenges prompted the development of a checking software specifically for technical drafting plates.

This study determined that the checking software be able to check technical drafting plates following a detailed scoring rubrics and display scores and feedbacks immediately utilizing the following technologies: Java Platform Standard Edition (Java SE), a compiler; NetBeans, an Integrated Development Environment (IDE); GitHub, a project management system and repository of codes; Kabeja, a java library for parsing AutoCAD entities; MVC Architecture, a software architecture pattern; and MySQL, an open source relational database management system. Functionality and portability were tested and became the basis for improvement; performance was subjected to International Standards Organization (ISO) 25010 software evaluation instrument.

TECHNICAL DRAFTING

Recognized as the "rising tiger of Asia", Philippines transitions into a progressive and newly industrialized republic as it secured the fastest growth rate among all other countries in Asia on the year 2016 (Yap, 2017). Part of this accomplishment can be regarded from the nation's continuous development in the education sector by providing a curriculum apt for 21st-century skills development. One result is the senior high school offering with different tracks or strand. In the new curricula are numerous supplementary subjects and short courses in the field of Information Communication Technology (ICT) and construction that provide students with competencies directly associated with their prospect line of work. Building and production-related subjects are also expansively offered as it is an aid to the existing needs of the country for it elevates industry and economy. One of these is the Technical Drafting course existent in the tri-focalized Philippine education in the secondary level. Technical drawing or graphics is widely used in many fields and professions as a medium of communication among technologists, engineers, architects, technicians, and so on (Chedi, 2015). It is applied in higher education, middle-level manpower and training, and basic education.

In higher education it is part of the four to five-year curricula of engineering, architecture, and related courses which include training of numerous computer-aided design and drafting applications as detailed, complex and must be congruent to the requirements of the field of mastery as it leads to professions such as licensed engineers and architects. As regards middle-level manpower and training TEC NC II duration of 148 hours are dedicated to enhancing the skills, attitude, and knowledge of trainees as draftsman or CAD operator. Completion of the training

declares the readiness of the trainee to undergo a national assessment in fulfillment of a Technical Drafting NC II national qualification which is highly credited on employment locally and abroad. In the basic education under the technical-vocational-livelihood (TVL) strand Technical Drafting is a specialization which covers 320 hours to achieve manual drafting and Computer-Aided Drawing (CAD) competencies leading to the same qualification and certification system of TESDA.

CHECKING SOFTWARE

Computing must have possibly ceased for users if not for the continuous development of software programs up until present times. Studies suggest that about 77% of its teacher-respondents affirm positive impact of technology in education as it makes their job less difficult (Nagel, 2018). This includes time spent and struggles in the assessment practice which can be resolved through ‘automation’ defined by William as cited by Romero, Noran, Stahre, Bernus, and Fast-Fast- Berglund (2017).” The number of automated checking software is developed and presently obtainable in the market equipped with different capabilities appropriate in various modes of assessment the likes of *Checking Software for Multiple Choice Assessment* called ZipGrade (Google Play, 2018), It is a mobile grading application capable of effortlessly scoring multiple-choice assessments while also capturing, storing, and reporting useful information in the Android device. Furthermore, it functions without internet connectivity but data can be optionally synced to the user’s created account online as it secures backups of all graded answer sheets through a companion website, www.zipgrade.com.

Another is the *Checking Software for Grammar, Spelling and Punctuation Errors* on essays and article writing called Grammarly. It is an application which is a cloud-based checker software that works by scanning through a text and automatically providing immediate feedback on grammar, spelling, and punctuation errors (Dianati & Navitas, 2015). Presently, the application likewise functions as an add-on on search engines such as Mozilla Firefox, Google Chrome, and Microsoft Edge as it automatically inspects spelling and grammar errors on Gmail, Facebook, Twitter, LinkedIn, Tumblr, and all other sites where the user has an ability to type in text (Mozilla, 2018). More than the ZipGrade and Grammarly applications, a number of checking software presently evolve in the market to advance and aid the current heavy workloads of classroom teachers especially for the traditional type of assessments.

CHECKING SOFTWARE FOR TECHNICAL DRAWINGS

More than multiple-choice and essay type of assessment, technical drawings as an output of performance is similarly one method which demands difficult and time-consuming assessment. A number of studies in the development of grading applications for technical drawings were accomplished.

The study of Deo (2010) presented the development of a back end component of an AutoCAD grading application for the CIV_E121_CX course in Civil Engineering which focused on logic and code programming implementation design. Although the primary purpose of the application is to provide real-time feedback during an AutoCAD session, it was later revealed to be impractical for the study and instead, provided the feedback after the completion of each exercise. Students are able to access the system by connecting to a remote server. The desktop application is only limited to two-dimensional drawings, and grades are derived based on the entities formats and organizational properties such as layer, color, line type, line type scale, and thickness. Items to be graded likewise include geometric properties for each object presented in the drawings. Points are achieved based on the number of properties accomplished by the learners and are presented by way of percentage format as the grade for the exercise. The system’s feedback also shows the correct elements on the student’s drawing which causes error identification difficult for students. Moreover, users must take some time to comprehend the format on how errors are displayed by the application, and few glitches are noticeable.

For that reason, Karna (2012) conducted an enhancement effort for the same research project in the Introduction of Computer-Aided Design (CIV_E121_CX) course through developing the system into an end-to-end web-based approach from its desktop application version and with an improved graphical user interface. The enhanced application utilizes internet connectivity prior to its intranet version which resolves issues on accessibility and security. The grading system for the version was also equipped with improved reliability due to prior’s leniency through adding the capability of considering variations and percentage of deviations as the basis of score. This is unlikely to the first version which is strictly point to point. Functionalities of the new system are also added with discussion boards for professors and students and capable of navigating to multiple pages or windows. However, the timeframe for completion and matching of submitted exercises on the quality and expected standards are the certain risk that the

system fails to address and is recommended for further improvement. Good internet connectivity is also a requirement as the accessibility of the application is web-based. Therefore, it is recommended to continuously improve applications with enhanced functions.

RESEARCH DESIGN AND METHODS

Agile model was used in the development of the computer-based checker for technical drafting plates. The development model is figuratively interpreted below.

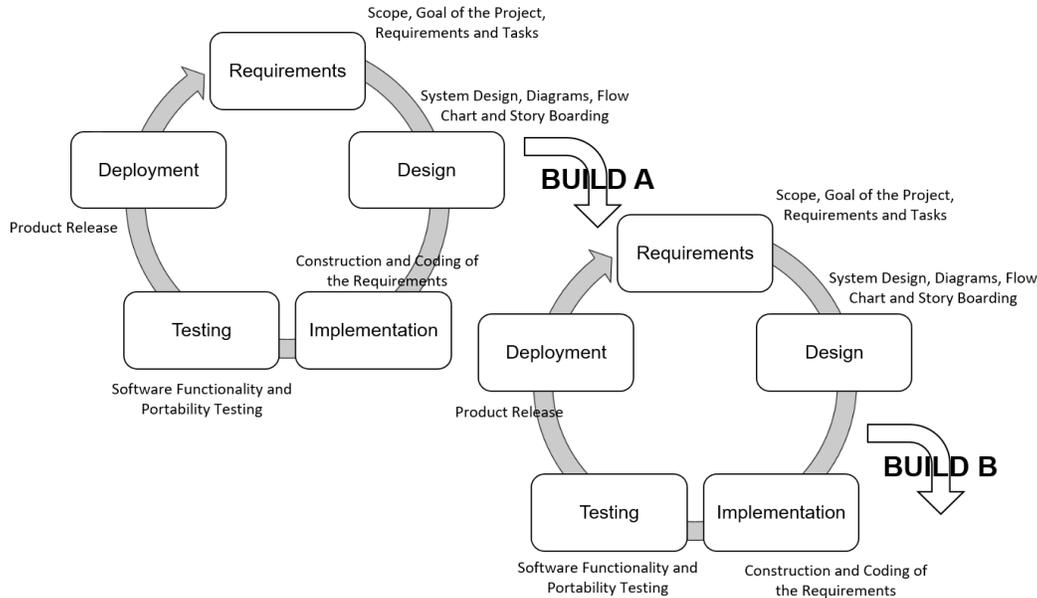


Figure 1. Stages of Agile Software Development Life Cycle (SDLC by Barracliffe, 2009)

As shown in Figure 1, the Agile method is comprised of five (5) iterative phases such as the requirements, design, implementation, testing, and deployment phase. Each stage was efficaciously executed before starting to the next and was not overlap with other phases. The Agile model guaranteed continuous attention to technical excellence, good design, and regular adaptation to changing circumstances.

In the *requirements phase*, the researcher examined the curriculum guide (CG) for Technical Drafting specialization for senior high school and identified the extent and restrictions of the computer-based software. The existing assessment method employed on students' output was also reviewed to initially design the system software. Six (6) TESDA accredited competency assessors in the same qualification were beseeched to corroborate a premature scoring rubrics developed by the researcher at the outset. The validated scoring criteria established the standard of the assessment scheme on the developed application. Software and hardware requirements in support of the development of the checking software are defined as follows:

Table 1.

Software and Hardware Requirements

| Software Requirements | Hardware Requirements |
|-----------------------|--------------------------------|
| Java SE | 1 GHz or faster Processor |
| Eclipse IDE | RAM 32-bit: 2 GB. 64-bit: 4 GB |
| GitHub Flow | Disk space: 4.0 GB |
| Kabeja Java Library | Computer Accessories |
| MVC Architecture | Network Devices |
| MySQL | |

To achieve the expectations derived from the limitations and standards determined, advanced technologies

and available libraries are presented in Table 1. These were the software utilized in the succeeding phase of project development. The hardware requirements presented matched the system demands of AutoCAD as the project was concentrated on checking computer-aided drawings created by the use of this design software.

Once polished, the system underwent the *designing phase* where technologies and available libraries were applied. Via system design tools like context diagram, DFD, ERD, flow charts, and hierarchical IPO, the collaboration between entities was precisely planned and the manner of data flow within processes in the system was established. Modules for each entity and storyboards were also deliberated to satisfy the system requirements elaborated on the previous phase.

On the *implementation phase*, the actual coding for the checking software was implemented while considering the requirements and design agreement on the previous phases of SDLC. It is the conversion of the aforementioned ideas into a realistic executable programming language code. Advanced technologies were operated specifically, Java as the programming language to code the application with reinforcement of Eclipse IDE, a text editor capable of detecting errors. A web-based application like GitHub (2017) as well functioned as the repository of the codes created. This was compulsory to view the modifications on the checking software throughout its development. Kabeja Java Library was likewise utilized as the parser or the information retriever of the DXF files saved from AutoCAD software. Furthermore, MVC Architecture managed and displayed the stored data from the MySQL, an open source relational database management system and controlled its functions. Potential errors also called as 'bugs' were detected and resolved from the software code to prevent the system from misbehaving unexpectedly or crash. Eclipse IDE assisted the system developer on this process by means of its source code editor, build automation tools, and debugger.

During the *testing phase*, the test-related activities, test case generation, testing criteria, and resource allocation for testing were recognized. The code was experienced and mapped against the scheme document created in the design phase. The output of the testing phase is a test report containing errors that occurred while testing the application. Alpha testing for the functionality and portability of the checking software were administered by a certified software quality assurance.

At the final phase of the agile methodology, the product was already prepared for assembly. This indicated that the portion of the system on the build was apt to be used in the real environment of all end users of the product. Feedbacks from its intended users were accommodated to enhance the system.

After the first build of a portion of the system, the Agile method was repeated until all features and design requirements were achieved and affirmed. The process kept involvement among the beneficiaries of the software on its development from time to time. Advantage of Agile method supported the phases to be repeated each build triggering early recognition of errors and immediate supplying of corrective actions. End-users, the students, and the teacher, with the help of TESDA competency assessors also participated in checking errors in real-life scenarios.

Exhibited by the figure below is a much-detailed overview (Level 1) of the checking software for technical drafting plates.

Demonstrated by Figure 2 is an increasingly detailed diagram, which describes the process of data flow within the developed system. It is comprised of three (3) modules such as the account registration, DXF file processing, and view dashboard; related to two (2) external entities, the faculty and the student; co-existing with its corresponding inputs and outputs. The sharing and exchanging of information from the types of users are likewise presented in connection to the system's database. The subsequent structural diagram describes the inter-relationship between these entities and the database.

To produce a high-quality database design, the ERD conferred by Figure 3 presented the employed overall architecture of the system and the relationships of entity sets stored in the database. There was four (4) entity sets shown interconnected specifically the accounts, activity, activity assignment and section entity. Based on the figure above, the accounts table holds several section tables that carry all of the activities that are created in the accounts table. Each of the activities has a corresponding activity assignment table recorded in accounts. These entities possess attributes that define its properties.

The system performance evaluation was conducted to a total of thirty (30) respondents selected through a purposive sampling technique. It is comprised of three (3) TESDA accredited competency assessors in Technical Drafting NC II; two (2) IT and computer professionals; five (5) teachers of technical drafting, and twenty (20) senior high school students under the same specialization from public and private school. The experts were purposely chosen because of their expertise in the assessment of drawing plates, software development, instruction, and classroom set-up of senior high school. IT professionals were taken as evaluators to assure system quality in a

technology experts' view. The teachers and students were similarly selected as they are the end-user of the project.

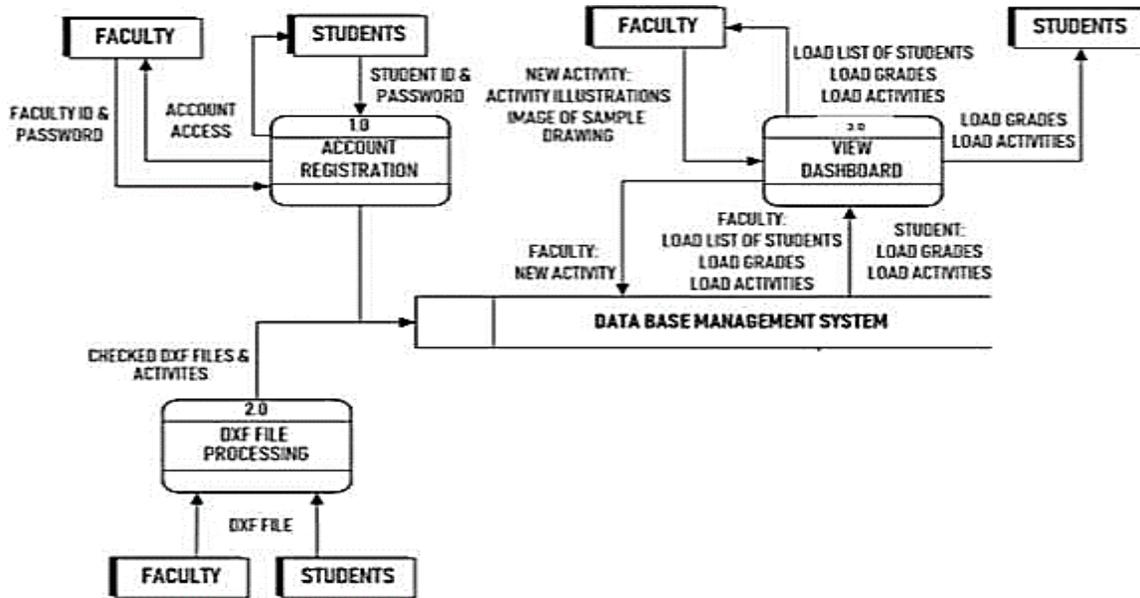


Figure 2. Level 1 Data Flow Diagram of the Computer-Based Checker for Technical Drafting

The software was evaluated using ISO 25010 Product Quality survey questionnaire in terms of eight (8) criteria namely: functionality, suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. The evaluation tool is an international standard for the evaluation of software quality. Likert scale with a numerical rating ranging from five (5) being outstanding, and one (1) as poor was adapted. As stated by Carillo, Mateo, and Monje (2012), there exists enough number of metrics to measure all the functional quality characteristics defined in the international standard ISO 25010. The gathered data were subjected to descriptive statistics.

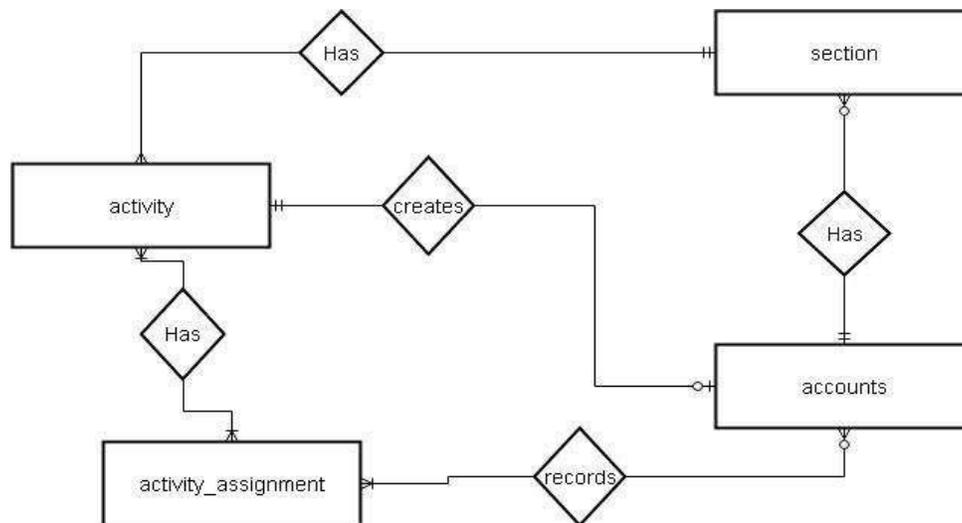


Figure 3. Entity Relationship Diagram (ERD) of the Checking Software for Technical Drafting Plates (CSTDp)

RESULTS

PROJECT DESCRIPTION AND STRUCTURE

Computer-based Checker for Technical Drafting Plates (CCTDp) or the checking software is a desktop LAN application software intended to assist teachers and students in a timely, reliable, and effortless assessment of computer-aided drawings prepared using AutoCAD software. Its features include the submission of technical drafting plates and the deployment of scores and feedbacks. There is also a registry of accounts protected with username and password accessible only by the account holder to provide confidentiality of each student's records.

The system focuses on checking plates following the Technical Drafting Curriculum Guide (CG) set by DepEd that covers five (5) Computer- Aided Drawing (CAD) competencies that a high school student ought to possess, such as 1) preparing CAD, 2) lay-outing structural details, 3) lay-outing electrical and electronic details, 4) lay-outing sanitary and plumbing details, and 5) lay-outing mechanical details. The drawings are also limited to two-dimensional objects drawn by the use of Autodesk AutoCAD design software. Its scoring and feedback are based on a TESDA validated scoring criteria encompassing line technique, accuracy, and completeness, annotations, plotting, and speed.

A user interface is similarly vital as the system functionalities since it has acted as the structure for communication between the user and the program. It pertains to the design including any aspect of the system perceptible to the user. For that reason, CCTDp is so structured with a graphical user interface containing windows, icons, and menus applied in most modern operating systems. The UI was collaboratively created using advanced technologies specifically Java SE, NetBeans IDE, GitHub, Kabeja, MVC Architecture, and MySQL 5.7 to handle the storage, retrieval, and updating of the records of the students. The checker developed is accessible via two (2) user accounts: the faculty, who also acts as the administrator account, and the students' account. Both are equipped with a differentiated graphical user interface.

PROJECT TEST RESULTS

Computer-based software for technical drafting undergone a series of testing procedures on its functionality and portability to test and map against the design document using the agile methodology. The conduct of the testing phase was performed by a certified software quality assurance in the foundation level of the International System Testing Qualification Board (ISTQB). The output of the testing phase are the test reports containing errors that occurred while testing the application in terms of its functionality and portability.

The table below shows major functions, test processes, expected outcome, and the actual result achieved by the developed checking software during the testing.

Table 2.

Faculty Module Test Cases (Functionality)

| Function | Test Scenario | Expected Outcome | Actual Result |
|----------------------------|--|--|--|
| Account Log-In | Input correct username and password | The system accepts the username and password. Redirects to Home Screen. Displays list of activities. | The system accepted the username and password. Redirected to Home Screen. Displayed list of activities |
| | Input incorrect username or password or blank field and vice versa | The system validation will appear with "Invalid username or password". Stay in the Log-in form. | The system validation appeared with "Invalid username or password". Stay in the Log-in form. |
| Faculty's Dashboard | Click VIEW ACTIVITY button on an existing activity listed | Redirects to View Activity Window | Redirected to View Activity Window |
| | Click EDIT ACTIVITY on an existing activity listed | Redirects to Edit Activity Window. Enables editing on the text fields. | Redirected to Edit Activity Window. Enabled editing on the text fields. |

| Function | Test Scenario | Expected Outcome | Actual Result |
|---------------------------------------|---|--|---|
| | Click back arrow icon | Go back to the home screen. | Went back to the home screen. |
| | Click NEW ACTIVITY button | Redirects to New Activity Window. Enables editing of text fields and uploads of DXF files with BROWSE FILE button. | Redirected to New Activity Window. Enabled editing of text fields and uploads of DXF files with BROWSE FILE button. |
| | Click BROWSE FILE button and select DXF file and click Open | Displays the DXF file path on the text field. | Displayed the DXF file path on the text field. |
| | Select template type on the template drop down arrow. | Displays a sample of the drawing template selected. | Displayed a sample of the drawing template selected. |
| | Click CREATE ACTIVITY button. | The Create Activity Alert Message will appear with “Activity successfully created!”. | The Create Activity Alert Message appeared with “Activity successfully created!”. |
| <i>View and Upload Student Scores</i> | Check the PUBLISH SCORES checkbox on View Activity screen | Publicize the scores for the particular activity on students’ account. | Publicized the scores for the particular activity on students’ account. |
| | Click the CHECK PROGRESS button | Redirects to the Check Progress Window. Displays list of students and their corresponding scores. | Redirected to the Check Progress Window. Displayed list of students and their corresponding scores. |
| | Click ADD STUDENT | List of newly created account for section will appear. Adds selected student on the activity | List of newly created account for section appeared. Added selected student on the activity |
| | Click VIEW SCORE button beside student’s name | Redirects to Student Activity Score Window. Display score of a particular student with feedback. | Redirected to Student Activity Score Window. Displayed score of a particular student with feedback. |
| <i>Account Management</i> | Click ACCOUNTS button in the sidebar of the home screen | Redirects to the Accounts Window. Displays NEW ACCOUNT, EDIT ACCOUNT and DELETE ACCOUNT buttons | Redirected to the Accounts Window. Displayed NEW ACCOUNT, EDIT ACCOUNT and DELETE ACCOUNT buttons |
| | Click NEW ACCOUNT button | New Account Window will appear. | New Account Window appeared. |
| | Fill up text fields for the new account and Click SUBMIT button | The system validation will appear with “Account successfully created!” | The system validation appeared with “Account successfully created!” |
| | Click OK button | System message will appear with “Would you like to create another account?” | System message appeared with “Would you like to create another account?” |
| | Click YES button | New Account Window will appear. | New Account Window appeared. |
| | Click NO button | Go backs to the Accounts Window. Displays the list of existing accounts with the new account created. | Went back to the Accounts Window. Displays the list of existing accounts with the new account created. |
| | Select an existing account. Click EDIT ACCOUNT button. | Edit Account Window will appear. | Edit Account Window appeared. |

| Function | Test Scenario | Expected Outcome | Actual Result |
|------------------------|--|--|---|
| <i>Account Log-Out</i> | Edit text fields for the account and Click SUBMIT button | The system validation will appear with "Account successfully updated!" | The system validation appeared with "Account successfully updated!" |
| | Select an existing account. Click DELETE ACCOUNT button. | Delete Account Window will appear with "Are you sure you want to delete account user?" | Delete Account Window appeared with "Are you sure you want to delete account user?" |
| | Click YES button | Displays "Account successfully deleted!" | Displayed "Account successfully deleted!" |
| | Click NO button | Redirects to the Account Management Window. | Redirected to the Account Management Window. |
| | Click the Account Log-Out link. | The user will log-out from the system. Redirects to the Account Log-in Window. | The user logged-out from the system. Redirected to the Account Log-in Window. |

According to Table 2, the modules controlled by the faculty account **all achieved the expected outcomes** presented in the final testing as described by the actual result column. Improvements from previous faults are due to possible human error caused by the user that shall be handled by the system. Thus, it was adjusted to operate on these types of possible scenarios in the classroom setting. Students' module test cases were likewise performed subsequently.

Modules specifically created for the student user account and its test cases also **all attained the expected actions** of the checking software. Some adjustments and corrections were inputs to progress the system in view of aiding the students with easy system navigation. Likely, to the faculty module test cases, real-life scenarios in a classroom setting are perceived and accommodated by the accounts. It is likewise made sure that the student accounts are tested to be monitored and connected to that of the faculty account. All of these were tested and achieved its desired result according to its functionalities.

The functionality testing was performed on Windows 7, 8, and 10 in six (6) major modules summarized by the table hereunder.

Table 3.

Overall Summary of the Functional Testing

| Test Cases | Total No. of Test Cases | Total TC Marked Passed | Total TC Marked Failed | Total TC's Marked Ready for Retest/No Run |
|---------------------------|-------------------------|------------------------|------------------------|---|
| Activity Module | 31 | 31 | 0 | 0 |
| Accounts Module | 17 | 17 | 0 | 0 |
| Section Module | 5 | 5 | 0 | 0 |
| Front-End Module | 6 | 6 | 0 | 0 |
| Add Student Module | 2 | 2 | 0 | 0 |
| Admin Module | 25 | 25 | 0 | 0 |
| TOTAL | 86 | 86 | 0 | 0 |

Table 3 reveals the total number of test cases performed for each module sums to 86 and were all marked passed. This status denotes that the actual results of the conducted tests met the expected result while a failed remark imply otherwise. There was no recorded failure of the system in the final round of testing, though initial testing showed some errors and they were detected and located within the program and resolved to preserve the correct operation of the checking software for technical drafting plates.

To determine if the developed system runs in different operating systems and tests the attributes of installability, adaptability, and compatibility, the portability test was administered. The table below indicates the result.

Table 4.

Overall Summary of the Portability Testing

| Attributes | Windows 7 | Windows 8 | Windows 10 | Status |
|--------------------------|-----------|-----------|------------|---------------|
| 1. Installability | Yes | Yes | Yes | PASSED |
| 2. Adaptability | Yes | Yes | Yes | PASSED |
| 3. Compatibility | Yes | Yes | Yes | PASSED |
| | | | | PASSED |

Table 4 shows passed status in all the required attributes. The free space, checking prerequisites, installation procedures, installation interruption, customization, initialization, and/or uninstall were also reviewed and noted. The functions of the system when running with multiple unrelated software while sharing the same resources were also achieved. It likewise passed the adaptability to Windows OS.

To find out the performance of the CSTDp, the descriptive statistics were utilized. ISO/IEC 25010 product quality evaluation was administered. Throughout the conduct of the research study, the values of the standard deviations are relatively small, which means that the scores of the evaluators in each criterion are not dispersed. Results are shown in the ensuing table.

Table 5.

Summary of the Descriptive Statistics of the Performance of CSTDp

| Criteria | Outstanding | Very Good | Good | Mean (\bar{x}) | Verbal Interpretation | Standard Deviation (SD) |
|--|-------------|-------------|-----------|--------------------|-----------------------|-------------------------|
| 1. Functional Suitability | 93.33% (28) | 6.67% (2) | 0.00% | 4.93 | Outstanding | 0.30168 |
| 2. Reliability | 80.00% (24) | 20.00% (6) | 0.00% | 4.78 | Outstanding | 0.47567 |
| 3. Portability | 83.33% (25) | 13.33% (4) | 3.33% (1) | 4.79 | Outstanding | 0.48562 |
| 4. Usability | 76.67% (23) | 23.33% (7) | 0.00% | 4.77 | Outstanding | 0.45869 |
| 5. Performance Efficiency | 90.00% (27) | 10.00% (3) | 0.00% | 4.83 | Outstanding | 0.37477 |
| 6. Security | 80.00% (24) | 20.00% (6) | 0.00% | 4.80 | Outstanding | 0.43350 |
| 7. Compatibility | 63.33% (19) | 36.67% (11) | 0.00% | 4.73 | Outstanding | 0.44595 |
| 8. Maintainability | 76.67% (23) | 23.33% (7) | 0.00% | 4.75 | Outstanding | 0.47680 |
| Grand mean (\bar{x}) | | | | 4.80 | Outstanding | |

It appears that raters agreed on the performance of the computer-based checker as it gained a grand mean of 4.80, which implies the outstanding performance of the software. The scores also highlighted the reliability of the system as it solves the inaccuracy of assessment as mentioned by Kim and Zabelina (2015) affected by factors such as culture and student background. Furthermore, the statement of Berchtold (2016) that assessment shall have the ability to conclude on the same scale when applied twice upon a particular respondent justifies the reliability of evaluation and referred to as the inter-rater agreement, was also satisfied.

Additionally, the functional suitability is rated with “outstanding”, better than other measures indicative of a high degree of provision employed in which the raters/evaluators recognized as meeting all their required needs in checking and submitting drafting plates. This is because of its salient feature that there is an interaction between the evaluator and the students using the system functionalities of the software. Furthermore, the compatibility of the system was rated the least, probably due to the system requirements, and it is still not tested to run in Mac. Additionally, the highest standard deviation was accumulated from the portability which describes that the responses are more varied among other criteria.

CONCLUSIONS

In light of the objectives of this study, the outcome of the testing, and the foregoing findings, the following conclusions were drawn. The project was successfully designed such that the system assesses architectural, mechanical, plumbing and sanitary, electrical and electronics, and structural layout and details which are the competencies of the course. The scoring rubrics as validated by accredited TESDA TEC NC II assessors possess the criteria such as line technique, accuracy and completeness, annotations, plotting, and speed which all can be checked and scored by the system. It instantly displays the overall score for the specific plate in percentage (%) format and breaks down these rating with the achieved points per criterion. Feedbacks are presented in addition to the numeric rating to contribute directly to the progress in learning.

All advanced technologies such as Java SE, NetBeans IDE, GitHub, Kabeja Java Library, MVC Architecture, and MySQL are utilized accordingly geared to the objectives. Each worked efficiently to successfully develop the checking software. The system was tested and improved according to its functionality using test cases and its portability to Windows operating systems. The testing results suggest that the software functions excellently and runs entirely on windows operating system such as Windows 7, 8, and 10.

The system was evaluated using the ISO 25010 Product Quality questionnaire and acquired a grand mean of 4.80, which implies outstanding. It shows that students, teachers, TEC NC II assessors, and IT practitioners recognize the checking-based checker for technical drafting plates as an effective and efficient computer-based system for the technical drafting specialization in senior high school. It also implies that the developed system facilitates feedback to the learners by providing the scores soonest satisfying the 21st century teaching-learning strategies inside the classroom. The accuracy, reliability and the timeliness by the developed software were addressed in the said performance-based assessment in technical drafting plates.

REFERENCES

- Barraccliffe, M., Gardner, L., Hammond, J., & Duncan, S. (2009). *Systems Development Life Cycle (SDLC) Methodology*. UC Santa Cruz, 1, 2009th ser. Retrieved September 13, 2018, from <https://its.ucsc.edu/drb/sdlc/documents/sdlc-handbook-reduced.pdf>
- Berchtold, A. (2016). Test–retest: Agreement or reliability? *Methodological Innovations SAGE Journals*, 9, 1-7. doi:10.1177/2059799116672875
- Carillo, A. B., Mateo, P. R. and Monje, M. R. (2012). Metrics to Evaluate Functional Quality: A Systematic Review, 7th Iberian Conference on Information Systems and Technologies (CISTI 2012), Madrid, 2012, pp. 1-6.
- Chedi, J. M. (2015). Technical Drawing/ Graphic Skills Acquisition for Teaching and Learning and Challenges in Technology Education. ATBU, *Journal of Science, Technology & Education (JOSTE)*, 3(3), 2015th ser.
- Deo (2010). AutoCAD Grading Application: Back End. (Master's thesis, San Diego State University, 2010). San Diego
- Dianati, S., & Navitas, M. C. (2015). 'You Want Me to Check Your Grammar Again?' How Online Grammar Checkers Can Complement Our Feedback to Students. *Critical Intersections: The 12th Biennial Conference of the Association for Academic Language and Learning*, University of Wollongong.
- GitHub. (2017, November 30). Understanding the GitHub flow. Retrieved September 8, 2018, from <https://guides.github.com/introduction/flow/>
- Google Play. (2018). Grammarly Keyboard — Type with confidence. Retrieved September 8, 2018, from <https://play.google.com/store/apps/details?id=com.grammarly.android.keyboard&hl=en>
- Google Play (2018). ZipGrade. Retrieved September 8, 2018, from <https://play.google.com/store/apps/details?id=com.zipgradellc.android.zipgrade&hl=en>
- ISO 25000. (2018). ISO/IEC 25010. Retrieved February 6, 2019, from <http://iso25000.com/index.php/en/iso-25000-standards/iso-25010>
- Karna, S. T. (2012). Enhanced AutoCAD Grading Application: Back-End Component (Unpublished master's thesis). San Diego State University.
- Mozilla. (2018). Grammarly for Firefox. Retrieved September 8, 2018, from <https://addons.mozilla.org/en-US/firefox/addon/grammarly-1/>
- Nagel, D. (2018, November 7). Teaching with Technology in 2018. Retrieved September 8, 2018, from <https://thejournal.com/articles/2018/07/11/teaching-with-technology-in-2018.aspx>
- Obaid, F. (2014). Pedagogical & Didactical Innovations Evaluation and Assessment of Students Learning. *Museums and Art Galleries of the Northern Territory Research*, 2(5), 1-7. doi:dx.doi.org/14.9831/1444- 8939.2014/2-5/MAGNT.1

- Paper Rater. (2018). Grammar Check. Retrieved February 6, 2019, from <https://www.paperrater.com/>
- Romero, D., Noran, O., Stahre, J., Bernus, P. & Fast-Berglund, A. (2017). Towards a Human-Centred Reference Architecture for Next Generation Balanced Automation Systems. *IFIP International Conference on Advances in Production Management Systems (APMS), Advances in Information and Communication Technology, AICT-460 (Part II)*, pp.556-566.
- Rosaroso, R. C., & Rosaroso, N. A. (2015). Performance-based Assessment in Selected Higher Education Institutions in Cebu City, *Philippines. Asia Pacific Journal of Multidisciplinary Research*, 3(4), 2015th ser., 72-77.
- Tuckwiller, B. L., (2012). *Teacher Perspectives on Performance Based Student Assessment in Career and Technical Education in West Virginia*, Public Schools Theses, Dissertations and Capstones. Paper 313.
- Yap, K. M. (2017, January 26). Rising Tiger Philippines Posts Some of the World's Fastest Growth. *Bloomberg News*.
- Zhang, M. (2013). Contrasting Automated and Human Scoring of Essays. *Educational Testing Service*, 21. Retrieved February 6, 2019, from http://origin-www.ets.org/Media/Research/pdf/RD_Connections_21.pdf