

A Comprehensive Analysis and Evaluation of Computer-based Testing Tools

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Abstract

Background/Objectives: The growth of the internet in the last few decades has given rise to the demand for computer- and web-based testing. The use of computers and web-based applications for assessing the knowledge, attitudes and skills of different people from different backgrounds with different specialities around the world are increasing day by day. **Methods/Analysis:** The needs for increased security, advanced test formats, more flexible scheduling, better measurement, automatic grading, psychometric analysis, and other effective administrative processes have made different testing agencies and organizations to consider converting the administration of their exams from conventional paper-and-pencil based to computer-based and online-based testing. **Findings:** In this article we are going to evaluate three different tools to tackle with the above mentioned problems and to provide a comprehensive information to those organizations who are planning to consider computer-based testing in future.

Keywords: Fasttest Web, Prometric IBT, Question Mark Perception, Web-based Testing Tools

1. Introduction

The growth of the internet in the last few decades has given rise to the demand for computer- and web-based testing. The use of computers and web-based applications for assessing the knowledge and skills for different communities are increasing day by day. Also differentiating between various item and test creation, delivery and security requirements for each tool of assessment becomes more important¹. In some cases, over-engineering low-stake exams could result in unnecessary cost and waste of time, while under-engineering high-stake exams could weaken people's confidence, organization's processes, and could challenge the face validity of the exams^{1,2}.

The needs for increased security, advanced test formats, more flexible scheduling, better measurement, automatic grading, psychometric analysis, and other effective administrative processes have made different testing agencies and organizations to consider converting the administration of their exams from conventional paper-and-pencil based to computer-based and online-based

testing³. Computer based testing offers a lot of options that have implications for test reliability and length, security, cost and maintenance, and other program needs for test administration that are not possible with traditional paper-and-pencil based tests⁴.

An important parameter regarding the distant learning and online education and testing is basically taking the exam through a computer connected to a network. In order to facilitate the subject matter experts (SMEs), administrators, and users in authoring, delivering, grading and analysing the tests and exams, special software tools are required. There are many tools available in the market to fulfil these needs and to carry out the exams online². Although, most of them share the same template, however there are major differences in their characteristics, layout and administrative procedures. In this paper we are going to evaluate and analyse the following three tools:

- QuestionMark Perception
- Fasttest Web
- Prometric IBT

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In the following section, we will briefly explain the three tools. In section three, we will compare them in tabulated form based on certain criteria. Finally, in section four, we will conclude and suggest some directions for the improvements of these tools.

2. Materials and Methods

In this section we will provide a comprehensive information about the tools that we are going to analyse and evaluate.

2.1 QuestionMark Perception

QuestionMark “Perception” is a complete and comprehensive assessment management solution that offers a cost-effective, easy way to conduct computerized based online and offline assessments or print and scan mechanism to measure the skills, knowledge and attitudes of the candidates at different educational level and background⁵. QuestionMark perception enables its user to create different type of questions and organize them into exams, quizzes, tests and surveys. The company was founded in 1988 and it works privately⁶. The company has almost 2600 customers for its perception product from different corporate, government and education markets and have their offices in US, UK and Belgium etc. the product support English, Spanish, German, French, Dutch and Japanese Languages.

2.1.1 Assessment Process

The QuestionMark perception enables trainers, educators and testing professionals to author, schedule, deliver and report surveys, quizzes and exams. The entire assessment process is shown in Figure 1. The assessment process is divided into four stages, and each stage is then further divided into sub-stages. The authoring stage is basically concerned with the creation of questions and grouping them into quizzes, surveys, exams and tests using a web browser or windows PC^{6,7}. The scheduling stage describe the procedures to create, add, import, change and delete participants, groups and their schedules. The delivery stage deals with delivering assessment through standard or secure browser, personal digital assistant (PDA) or windows PC, while the report stage deals with the creation of reports on the results. The reports contains coaching reports, item analysis reports, gap analysis reports etc.

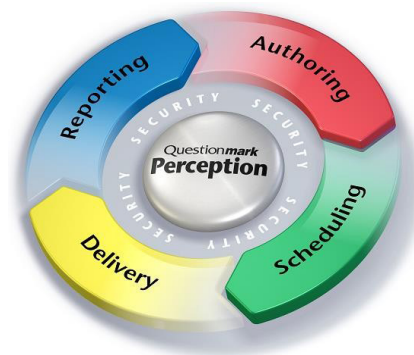


Figure 1. Assessment Process of QuestionMark Perception.

2.1.2 Authoring Stage

QuestionMark enables learning professionals, educators, testing professionals and subject matter experts (SMEs) to author questions, organize them into surveys, exams, tests and quizzes. QuestionMark supports 21 different kinds of questions the detail of which is given below⁷.

i. Drag and Drop

The candidate or the examinee may clicks and drags up to ten images into position. The feedback and score depends upon the final position of the images.

ii. Essay Questions

The candidate may answer the question by typing up to 30,000 characters of text. Customizable rubrics, presence and absence of keywords or key phrases could be used to grade such type of questions.

iii. Job Task Analysis

Job task analysis surveys are used to highlight what task within a job are most important. These type pf questions are normally used to construct and validate certification programs and to make sure that the asked questions are relevant to the job.

iv. Explanation screens

In this type of question the SMEs or educators may insert text or graphics for the candidate to view prior to answer a series of questions.

v. File Upload

The candidates are often asked to complete an assignment which required the creation of file by using a computer.

The created files are then uploaded to the system in order to complete the question.

vi. Fill-in-the-blanks

The candidates are presented with a statement where one or more words are missing and they have to complete those missing words. A list of acceptable words is pre-defined in order to check it with the blanks to calculate the grades.

vii. Hotspot

The candidates click on a picture to mark their choice. Certain grades will be assigned based on the candidate choices. A graphic editor is normally provided is such type of questions in order to simplify specifying the choice area.

viii. Knowledge Matrix

In this type of question the SMEs presents several type of multiple-choice questions together where the candidates needs to select one choice for each statement or question presented. These type of questions are normally used to cross-relate responses from a single item. Example of a simple Matrix Question is given below.

Classify each device or component as either an input device or an output device⁸.

keyboard	<input type="radio"/>	Input	<input type="radio"/>	Output
mouse	<input type="radio"/>	Input	<input type="radio"/>	Output
monitor/display	<input type="radio"/>	Input	<input type="radio"/>	Output
microphone	<input type="radio"/>	Input	<input type="radio"/>	Output
printer	<input type="radio"/>	Input	<input type="radio"/>	Output

ix. Survey Matrix

This type of question enables the SMEs to include multiple rows of Likert questions within a table with column headers included. Example of survey matrix question is given below.

What did you think of today's seminar?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The presenter was knowledgeable about the subject.	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>

The instructions to access the web seminar were excellent.	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>
The audio quality was excellent.	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>
I learned things that I can apply at work.	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>	choose <input type="radio"/>

x. Likert Scale

The candidate may select one of the several options such as strongly agree through strongly disagree that are weighted with numbers in order to aid analysis of the results.

xi. Matching

In this type of questions two series of statements/words are presented to the candidates in order to match items from one list to the items of other list.

xii. Multiple Choice

In this type of question the candidates needs to select the best matching choice from almost 40 possible answers.

xiii. Multiple Responses

This type of questions are just similar to the multiple choice questions except the candidates are not limited to select one choice, but they can select none, one or more than one choices from the offered list.

xiv. Numeric questions

The candidate is prompted to enter the numeric value, and this may be scored as one value for an exact answer and another score if the required responses are within a range.

xv. Pull-Down List

In this type of question a series of statements are presented to the candidate and the candidate will match those statements with a pull-down list.

xiv. Ranking

In this type of question a list of choices must be ranked by the candidate without any duplication. The ranking must be in order.

xvii. Select-a-blank

The candidates are presented with a statement where a word is missing, and they have to select a word from a pull-down list to indicate their answer.

xviii. True/False

In this type of question the candidate has to select “true” or “false” in response to a question.

xix. Word response

In this type of question the candidate will type a single word or few words to indicate their answer. The SMEs will enter a list of acceptable responses in order to grade the question⁸. Also scoring can be made on the basis of presence or absence of keywords or key phrases.

xx. Yes/No

In these type of questions the candidates will select “yes” or “No” in response to the questions.

xxi. Adobe Flash

Perception supports an interface with Adobe Flash that allow programmers to program customized items using Flash and have the results recorded within the answer database.

xxii. Adobe Captivate Simulations

Perception supports an interface with Adobe Captivate that allows subject matter experts to create simulations that can provide scoring information for multiple interactions and have the results recorded within the answer database.

2.1.3 Importing and Exporting Questions

Questions can be imported or exported to and from QuestionMark perception. QM perception uses QuestionMark live to import questions from different platforms where they can be viewed, modified, shared and exported as Qpacks. QM live supports the following formats in order to import the questions⁷:

- LXR test 6.1 Merge
- Blackboard 6/8/9 pool
- Blackboard upload
- QuestionMark Live CSV: It's a new format specially created for QM live and allow the users to create questions in Excel or any other text tool that is in the format of CSV file. The CSV file is then imported to the QM live.

- QuestionMark Qpacks
- Moodle XML

QM live supports all of the above formats and questions which are formatted according to these formats could be easily imported to the system. The imported questions are stored in their own question set, where they can be reviewed and modified. Once the questions are ready in Qpacks, they can be uploaded to the perception.

QM perception also supports some other formats where the SME's can directly import questions to perception. The SME's will first convert their questions to specified format and will then import it to the system. The conversion should be carried to one of the following formats^{6,7}.

- Conversion to QTI XML

This option may be appropriate with a tool that can convert the contents to QTI XML format. Once the conversion is done, you can easily import the contents to the perception by using the Authoring Manager.

- Conversion to ASCII

In this method the authors can add their contents to Microsoft word or any other similar word processing tool. Once the format is finished, the authors will save the file in ASCII format and will upload it to the perception by using the ASCII import tool in the authoring Manager.

- Conversion to QML

Question Mark-up Language (QML) is the native language for describing questions in perception, and all questions are stored in the database as QML. The authors or SME's can convert their contents programmatically to QML format to make it ready for importing to perception. This method is appropriate for large amount of similar contents in computerized format.

- Adding questions individually to perception

This option is appropriate for small amount of data where the authors can directly copy and paste the contents into the perception.

Exporting questions and assessment can be done by using the Qpacks in QuestionMark live. The authors can export the question set to Qpacks and can email them to anyone. The authors can also export the assessment in the same way.

2.1.4 Delivering Exams

Once an assessment has been authored and scheduled, it can be delivered on many different ways to the participants. There are four main delivery options offered by QuestionMark perception.

2.1.4.1 Web Delivery

An assessment scheduled for web delivery can be taken by the participant by using any internet browser. In some cases, additional software may also be required if the assessment includes some special contents such as Adobe Flash or PDF contents⁵. Also the perception will first check the participant browser for certain minimum requirements by using its browser checker application. If the browser meets the requirements, the assessment will be delivered, otherwise the assessment will be terminated. There are several different methods to take the assessment using the web delivery option^{6,7}:

Open Access: There is no security provided on this type of delivery and they are recommended for low-stake assessments such as quizzes and surveys.

Secure Access: Medium type of security is provided on this type of delivery and they are also recommended for low as well as medium stakes exams or assessments.

Certified Access at a Test Centre: Only a specified Monitor or Proctor assigned to a test centre can authorize and start the assessment. The Proctor or monitor will first login to perception in order to authorize the assessment. The monitor will specify the test centre ID along with his own name and password.

QuestionMark Secure: Most of the browsers are designed to be open and flexible and because of that far more security is required to deliver the assessment securely. QuestionMark secure provides a secure environment where high stake assessment and exams could be delivered. The administrator will simply need to install the QuestionMark secure on their PCs. QuestionMark secure provides the following facilities for delivering assessments:

- The display will always be in full screen and it's not possible to maximize or minimize the screen
- There are no menu bars and QuestionMark displays its own toolbar. Also there is no windows caption bar
- A vertical scroll bar will always be displayed, while a horizontal scroll bar will appear only when needed.
- The contents of the screen displayed will exactly be the same as in internet explorer.
- No history will be stored for any visited page.

QuestionMark provides the user interface in different languages and the participant can change the interface to

its desired language by selecting any of the available languages.

2.1.4.2 Paper Delivery

QuestionMark perception provides the facility of paper based assessment as well rather than online. In this way assessments or exams could be printed and could be taken on paper. A more organized way of delivering the assessments on paper is to use the Questionmark's printing and scanning solution. Using the printing and scanning option, exams could be printed and delivered on paper. Once the papers are ready, they could be scanned and uploaded to the perception for reporting.

2.1.4.3 Offline Delivery

Another way of delivering the exams and assessment is that of offline delivery. In this method the administrator will first distribute the contents to the participants by using any of the following ways:

- **With Perception:** In this way the assessment will be scheduled for delivery with QuestionMark TO Go. The participants will log on to the perception and will download the assessment.
- **With a Learning Management System (LMS):** In this way the assessment will be published to an LMS, and the participants will log on to the LMS and will download the assessment.
- The assessment can also be transferred to the participants on CDs, memory stick, email, FTP or any other way of transferring.

In the first two methods the participants will need the internet connection for enough time to download the assessment. Once the download will finish, the internet connection will no more required.

2.1.4.4 Third-Party LMS Delivery

Another way of delivering the assessment as that of Third-Party learning management system. Example of such systems are Blackboard, SAP enterprise Learning and Moodle. In order to do so, the author or administrator will first publish the assessment to LMS by using the authoring manager or browser-based authoring to create a content package that could be read and imported by the LMS. The content package is basically a Zip file containing the information regarding the assessment along with links to the URL on perception server where the assessment could be taken^{6,7}.

2.2 FastTest Web

Fasttest Web is an internet application designed to support the entire test development cycle, to improve the process of developing assessment and to make them more psychometrically rigorous. With advanced item banking, item response theory, test assembly tools, secure delivery and powerful reporting, Fasttest web is the most advanced testing platform available⁹. Fasttest web is designed by the expert psychometricians in order to make the test development cycle more effective and efficient. Fasttest web provides the facility to manage users, create banks of items, assemble the items into tests, build test sessions to administer the examinees, schedule the examinees, deliver tests online and generate reports. There are two main areas in Fasttest web, one is called the workspace area while the other one is called the item explorer area^{9,10}.

2.2.1 Creating banks and categories

After having created the area where the user can store the items and tests, the next step is to open one or more banks where the user will save the questions/items and from where the user will select items to create the tests and exams¹¹. Fasttest's item banks are designed to accommodate the hierarchical structures so that the bank can reflect the structure of a curriculum, the need of large item banking projects, and other application for which the structured item banks are useful. The user can place the items in any category, and the items can be freely moved among the categories within a bank or between banks within a workspace¹².

2.2.2 Supported Item Types

Fasttest web offers a variety of item response types that are designed to be applicable to a wide range of assessment situations. The Fasttest web has constructed each item type in such a flexible way in order to maximize the creativity of the development team in providing high quality, high fidelity items. Fasttest web uses the following item types^{12,13}.

i. Multiple Choice

In these kind of questions the examinee will select the single best answer. Allowing partial credit items, true false items and Likert-type items makes the customized response scoring more flexible¹².

ii. Multiple Response

These kind of questions are similar to multiple choice but in this case the examinees can select more than one

responses. The item score will be the sum of all answer weights¹². This format is useful for scenarios such as describing a medical patient and asking for the number of most appropriate diagnosis methods, or providing a list of animals and asking for a list of reptiles.

iii. Short Answer

These kind of questions provide a small text box to the examinee for his response. The responses are restricted to character length and normally it's a single word or phrase. Subject matter experts (SMEs) or the authors normally used these kind of questions for survey type questions.

iv. Scored Short Questions

Similar to short answers but the responses carries the score and the system automatically scores the response. The responses should be character specific and should be similar to the one provided by the examiner.

v. Essay

In these kind of questions a rich text editor is provided to the examinee in a familiar format where the examinee can write an essay just like in word processing program. The examiner can also turn off the rich text effects in order to facilitate the examinee to concentrate on writing.

vi. Drag and Drop (Droppable list)

In these kind of questions the examinees are allowed to select the options by dragging them onto a list. They are designed for items where the examinees are presented with 5-7 statements and are asked to select the best 2 or 3 statements that support the reasoning.

vii. Drag and Drop (Placeable list)

These kind of questions allow the authors to create any item where the answer should be placed in a specific spot. This includes both text (ideal for cloze items and ranking items) and image (drag sites onto a map, points onto a graph, labels onto an anatomy diagram) etc.

viii. Proofing

These kind of questions are normally used for items that needs proofing/editing by the examines.

ix. Survey

Survey questions are basically used for gathering the information from the examinees regarding the online tests. They are normally appeared at the start of end of the exam.

x. Likert-Type

These type of questions are designed to provide the ability to evaluate examinees using a rating scale¹². The rating scale consist of the options such as Agree, Strongly Agree, Natural, Disagree, Strongly Disagree etc.

xi. Instructions

These type of questions are used to deliver instructions and to provide instructional screens to the examinees.

xii. Fill in the Blanks

These type of items allow the authors to specify one or more spots in an item that require a typed response from the examinee. In such kind of questions the examinees are asked to fill in two lists i.e. pros and cons etc.

2.2.3 Importing and Exporting Items

Entering each item singly would likely be exorbitant and would take longer time. The best way to tackle this problem is to import the existing banks and items in a single go¹⁴. Fasttest web supports seven different formats in order to import items, the detail of which is given below:

2.2.3.1 FastTEST 2.0 Format

Items that are exported from the PC-based FastTEST 2.0 can be uploaded with no modification. Simply export the required fields and save it in RTF file, open it and make the required changes, and then save it again in Microsoft word keeping the same .rtf extension. Finally import this RTF file into Fasttest web¹⁴.

2.2.3.2 Word 2003 XML Format

Fasttest web can import text items, images and correct answers in Word 2003 XML format. This method is more beneficial for those users who have item texts in a word document without any other information such as Author, Source or any other statistics. The user will simply put a manual page break between each item and will save the file as Word 2003 XML file, and will finally upload it to the Fasttest web.

2.2.3.3 Tagged (@@) format

Fasttest web also supports the same import tags that are utilized from importing in the PC-based Fasttest web¹⁴. All the tags utilize the same “@@” format, for example the author name is tagged with @@AU=. This type of import files could either be an RTF or TXT file. This format is

specifically designed for users who have a large amount of ancillary information. However the tagged format didn't support the tables and test boxes.

2.2.3.4 QTI 1.2 and QTI 2.1 Format

The IMS question and test interoperability (QTI™) specification enables the exchange of item, test and results data between authoring tools, item banks, test constructional tools, learning systems and assessment delivery systems [http://www.imsglobal.org/question/]. If the items have been exported by another banker in QTI 1.2 or QTI 2.1 formats, that files could be imported to Fasttest web. The supported file extension should be .xml.

2.2.3.5 Simple Text Format

For simple items with no specific format or any accompanying metadata can easily be imported to Fasttest web with the help of simple text format. The supported file should be saved as .txt file.

2.2.4 Delivering Tests

Fasttest web can deliver tests both traditional paper and pencil based or online based through secured web browser. Paper and pencil based tests needs just to print the tests after finalizing its contents, while online tests needs the creation of tests sessions, uploading examinee lists, purchasing test credits, and finally emailing the test codes to either the examinees or proctors¹⁵.

2.2.4.1 Paper and Pencil Based Testing

Fasttest web offers the facility of traditional paper and pencil based tests to its users and administrators. Once the test has been assembled, it can be printed or downloaded for paper-based test delivery. Fasttest web provides a number of choices of formats for downloading the tests like RTF, PDF, Doc, Excel, and HTML¹⁶. Once the tests are downloaded, they can be printed or edited in a number of ways in order to make it more easier and convenient for the examinees and proctors. Finally the examinees tested through paper and pencil based tests responses could be uploaded to the system in order to score it. In this case each examinee response will need half of a test credit to grade and store the responses.

2.2.4.2. Online Delivery

The first step in online testing is to upload the list of examinees and to assign tests that are to be taken. Next step is the availability of test credits and if the test credits are avail-

able, the following step will be sending the test codes to the examinees or proctors¹⁵. The test code is a unique and special code generated by Fasttest web for each examinee and must be entered into the web browser to start the exam. Test codes could be used for a number of test types e.g. if a test is a low-stake, and the examinee can take it anywhere and anytime without the intervention of a proctor, then the test code needs to be simply email to the examinee in order to login to the browser at his convenience. Similarly if the tests are high-stake, such as professional certifications, then it must be proctored at a testing center, and, the test codes will be sent to the proctor. The proctor will use the code to login and will ask the student to start the exam¹⁷.

2.2.4.3 Weblock online Delivery

Weblock is a client application interface for internet explorer and safari in order to make the online testing secure. Weblock will not modify the existing copy of IE or safari but will install a separate program that will display the custom browser¹⁸. Also Weblock will use the same security features that are currently installed on IE or safari. Weblock creates a locked or secure testing environment for the online assessment and will provide the following features.

- Assessment will be displayed in full screen and will not be minimized. Also test cannot be exited in the middle but can only be exited once it will be submitted by the examinee for grading¹⁷.
- Switching between tasks or accessing other applications during the exam are prevented.
- Printing functions such as print screen, print test or capturing screens are disabled.
- Copying and pasting, right click options, key + click options (Mac), browser menu, functions keys (F1-F12) and toolbars options are all disabled except Back, forward, refresh and stop keys¹⁸.
- Source code for the HTML page cannot be displayed and also other URLs cannot be accessed within the Weblock.
- Screen capturing, messaging, screen sharing, and other network monitoring applications are blocked from running, and the browser will start automatically at the examinee login page.
- Pages from the tests will not be stored or cached in the browser history listing.

2.3 Prometric Internet-Based Testing (IBT)

Prometric internet-based testing provides the facility to deliver tests over the internet with a minimum of technology on the user side. IBT allows clients to author and administer tests using the internet, and candidates to access tests over the internet, allowing the process of development to be more quicker and tests to be more accessible. In order to run the Prometric IBT web application smoothly, certain minimum requirements must be assured e.g. enabling Java script, enabling session cookies, disabling pop-up blockers, and at least a 56k modem connection per user is recommended¹⁹. Prometric IBT supports a range of languages and the candidate can select any language based on the availability. The list of languages include English, French, German, Italian, Japanese, Korean, Portuguese, Russian, Simplified Chinese, Spanish and Vietnamese. Also a new language could be added based on the user requirements.

2.3.1 Authoring Test

Author test is used to create new tests, pre/post tests, test forms and folders. It is also used for editing tests, reviewing test history, set authoring security, changing test status, previewing tests, copying tests, adding test folder associations, making test into other test forms, and making test forms into stand-alone tests¹⁹.

2.3.2 Creating a new Test

Creating a new test in Prometric internet-based testing is a five step process. Each step helps define a part of the test. The detail of each step is given below¹⁹.

2.3.2.1 Basic Information

The basic information step is the step where the user defines the properties of the test and is further divided into three sections.

- Basic test information and delivery parameters
- Proctoring, eligibility, availability and timing parameters.
- Scoring options

2.3.2.1 Sections

This part allow the user to group items into the test. A section or subsection could be divided based on topic or concept, question type, or any other way the user likes to logically divide the item banks. The user can also specify a criteria

based on a section that must be passed in order to qualify the exam. Similar criteria could be applied to a subsection as well.

2.3.2.3 Item Management

Item management is further divided into Item Media Management and Item Bank. Item media management is basically the central repository where all media items are managed. Media items include images, audio, video or flash files that will be used in the test. In order to use any media item in the test, the user or author will first upload the file.

Item banks are basically the pages or places where the items are listed. In item banks the author can create items, edit items, preview items, delete items that are not delivered, and retire items. The available question are item types in Prometric IBT for item banks are¹⁹:

- Single response
- Single response (Gradient Scored)
- Multiple response (No partial credit)
- Multiple response (partial credit)
- True/False
- Matching
- Essay (Human Graded)
- Short Answer
- Survey-Essay (Unscored)
- Survey-Short Answer (Unscored)
- Information Only (Unscored)
- Fill in the Blanks (Human Graded)
- Fill in the Blank (Auto)
- Drag and Drop
- Hot Spot
- Likert Scale
- Flash Simulation
- Voice Capture
- Import Items for Existing Test
- Import Items from Excel CSV file

2.3.3 Delivering Tests

Test delivery option in the Prometric IBT depends on the test setting specified by the author at the creation of item bank. Over there different options can be set for the delivery e.g. optional item setting provide the facility to set that how many items will be delivered in each section. Similarly the authors can put multiple items per page and can set the option regarding the page breaks wherever he wants. Also branching is another option where the author

can put a constraint on the candidate navigation during the test¹⁹. The author can allow the candidate to navigate back and forth or can disable the navigation during the entire exam. Moreover in the no test delivery option the author can hide the delivery option and can select the full random item delivery where all items are mandatory.

2.3.3.1 Gated Test Delivery

In gated test delivery the proctors can create and manage proctored test delivery to multiple candidates at one time. Each gated event include the test title, gate code, number of candidates waiting for the gate to be opened, and a link to make the gate active or inactive. To start the test the proctor will first select the list of candidates how may start the exam and will then start the test¹⁹.

2.3.3.2 Paper and Pencil test Delivery

Paper and pencil tests provides the facility to create the paper and pencil versions of the test for new and existing test events. The test can be created in PDF or HTML format. After the completion of test and hand score, the test level, pass fail status and score earned could be entered to the system.

2.3.3.3 Prometric IBT Lockdown Browser Delivery

Prometric IBT lockdown browser increase the exam administration security and facilitates testing larger groups with less number of proctors than an IBT exam without a lockdown browser. It works as an add-on to the IBT product and have the following characteristics:

- The new lockdown browser install faster and easier than the previous versions
- The browser is pre-configured, so there is no need to do anything, just install and use. Some particular applications can also be enabled or disabled if desired.
- The candidate scores can be printed easily by using the print key
- Supports different operating systems and platforms.

3. Analysis and Discussion

In this section we will analyse QuestionMark perception, Fasttest Web and Prometric IBT based on certain characteristics discussed in the previous section. These characteristics include the supported question types, item and exam importing and exporting options, and Exam delivery

options. We will make the comparison in a tabulated form and will explain each table in detail.

Table 1. Comparison of web based testing tools based on Question types

S. No	Question Type	Question Mark	Fasttest Web	Prometric IBT
1	Drag and Drop	ü	ü	ü
2	Essay Questions	ü	ü	ü
3	Job Task Analysis	ü	x	x
4	Information Only (Unscored)	x	x	ü
5	Flash Simulation	x	x	ü
6	Voice Capture	x	x	ü
7	Explanation screens	ü	x	x
8	File Upload	ü	x	x
9	Fill-in-the-blanks	ü	ü	ü
10	Hotspot	ü	x	ü
11	Knowledge Matrix	ü	x	x
12	Survey Matrix	ü	ü	ü
13	Likert Scale	ü	ü	ü
14	Matching	ü	x	ü
15	Multiple Choice	ü	ü	ü
16	Multiple Responses	ü	x	ü
17	Numeric questions	ü	x	x
18	Short Answer	x	ü	ü
19	Instructions	x	ü	x
20	Pull-Down List	ü	x	x
21	Ranking	ü	x	x
22	Select-a-blank	ü	x	x
23	True/False	ü	x	ü
24	Word response	ü	x	x
25	Yes/No	ü	x	x
26	Adobe Flash	ü	x	x
27	Adobe Captivate Simulations	ü	x	x

28	Import Items for Existing Test	x	x	ü
29	Import Items from Excel CSV file	x	x	ü

Table 2. Comparison of web based testing tools based on Exam Delivery Options

S. No	Exam Delivery Option	Question Mark	Fasttest Web	Prometric IBT
1	Web Delivery / Online Delivery	ü	ü	x
2	Paper Delivery / Paper and Pencil Based Testing	ü	ü	ü
3	Offline Delivery	ü	x	x
4	Third-Party LMS Delivery	ü	x	x
5	Weblock online Delivery / Prometric IBT Lockdown Browser Delivery	ü	ü	ü
6	Gated Test Delivery	x	x	ü

3.1 Comparison based on Question Types

Table 1 will summarize the tools based on the question types they support for the creation of item banks. The table shows a comparison of QuestionMark, Fasttest Web and Prometric IBT based on the type of questions they support. For example drag and drop and essay questions are supported by all three tools. Similarly fill in the blanks, survey matrix, Likert scale, and multiple choice are also supported by all of them, while hotspot, true/false and some others are supported only by QuestionMark and Prometric IBT and not by Fasttest web. Moreover few of them are supported by Fasttest web but are not supported by the other two.

3.2 Comparison based on Exam Delivery Options

Table 2 will provide a comprehensive overview of different exam types offering by different tools. For instance, paper and pencil based test delivery is supported by all of the three

tools. Paper and pencil based testing is a traditional way of testing and the tools provide this facility by downloading or exporting the entire exam in any of the available format. After exporting the exam, the examiner simply needs to print the test and will distribute it in the participants. After completing the exam, the examiner may have the choice to upload the test back to the system for marking and psychometric purpose or may have the option to grade it manually and then upload it to the system for statistical analysis and reporting.

Table 3. Comparison of web based testing tools based on items and test importing types

S.No	Importing Type	Question Mark	Fasttest Web	Prometric IBT
1	LXR test 6.1 Merge	ü	x	x
2	Blackboard 6/8/9 pool	ü	x	x
3	Blackboard upload	ü	x	x
4	QM Live CSV/ Excel CSV	ü	x	ü
5	QM Qpacks	ü	x	x
6	Moodle XML/ Word 2003 XML	ü	ü	ü
7	FastTEST 2.0 Format	x	ü	x
8	Tagged (@@) format	x	ü	x
9	QTI 1.2 and QTI 2.1 Format	x	ü	x

Similarly Weblock online delivery or lockdown browser delivery is another way of delivering the exam online in a secure way. In this way of delivery the browser are locked and have no open option for any copy/paste, screen shots or accessing any kind of other web pages during the exam. This method of delivery is more beneficial for both low stake and high stake exams and are supported by all three testing tools.

Moreover offline delivery and third party LMS delivery is another way of delivering the exams and are only supported by QuestionMark. In the offline test delivery option, there is no need for any internet connection and the exam could

be delivered by using the computers, IPads, and other electronic devices. Once the exam is completed the device will need to be connected to the internet for a while to upload the exam to the system. These kind of methods are highly recommended for low stake exams. Finally gated test delivery is only supported by Prometric IBT.

3.3 Comparison based on Item and Exam Importing and Exporting Types

Table 3 details the information regarding a comparative analysis of the online testing tools based on item and test importing types. There are different ways to import the items and tests in the available tools. For example Moodle XML or word 2003 XML is a common format that is supported by all three types. In this method the items are first formatted according to the software requirement and then saved as a word 2003 XML file. This file is then imported into the system in order to import a bulk of items at once. This method is more beneficial for the SMEs and administrators if they have a large number of items in word or txt format. Similarly a whole test can be imported in the same way to the system.

Moreover LXR test 6.1 merge, Blackboard 6/8/9 pool, Blackboard upload, QM live CSV and QM Qpacks are the specified formats for the QuestionMark, while Fasttest 2.0, tagged @@, QTI 1.2 and 2.1, and Excel CSV are the formats supported by Fasttest web and Prometric IBT respectively. Import items from existing test is a special type supported by only Prometric IBT. In this type of import the items are directly imported from an existing test and are uploaded to the new test. This method is more favourable in the case where a test is retired long time ago and the user wants to import some items from that retired test to the ongoing test.

4. Conclusion

The ultimate objective of this study was to evaluate and analyse QuestionMark perception, Fasttest Web and Prometric IBT based on certain characteristics and to come up with a conclusion that which particular tool could be used for internet based testing. Based on the comparison we have mentioned in section 3 we could conclude that different tools could be used for computer-based testing under certain circumstances. For example Weblock online delivery or lockdown browser delivery is a way of delivering the exam online in a secure way. In this way of delivery the browser are locked and have no open option for any copy/paste, screen shots or accessing any kind of other web pages during the

exam. This method of delivery is more beneficial for both low stake and high stake exams and are supported by all three testing tools. Similarly one of the tools provide offline delivery option, which means that the exam could be carried out without any internet access. These kind of exams are more beneficial for places where we have a difficulty with the internet access. Such kind of delivery options are normally used for low-stake exams. Moreover the tools provide a support to different methods used for importing and exporting the items and questions from different layouts and platforms. All the tools support the basic formats, which are necessary for any web-based or computer-based testing tool in order to facilitate the subject matter experts.

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