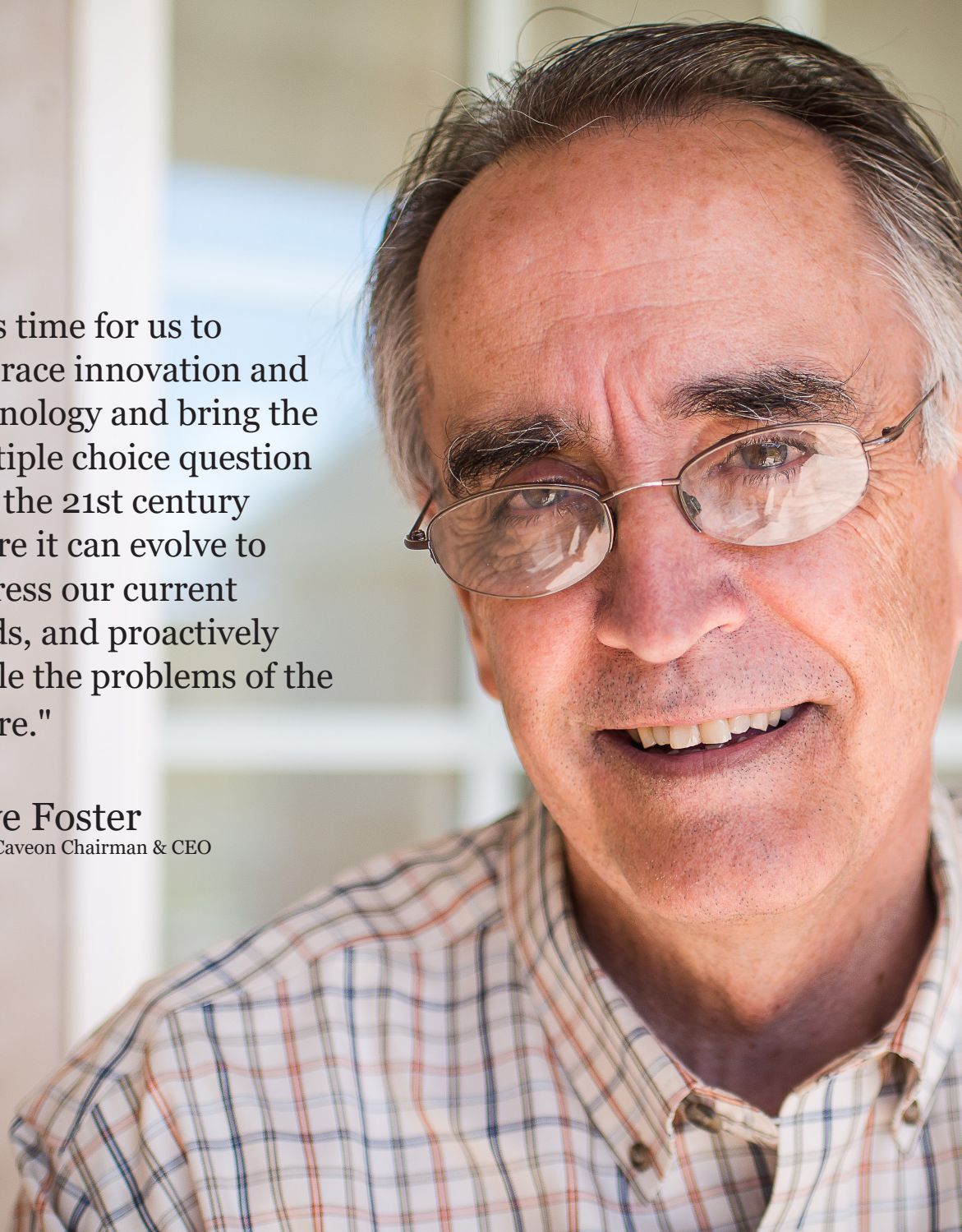# SmartItem™

Designing the Future of Testing

caveon™

What is a SmartItem?

A SmartItem uses special technology during development and delivery so that the item changes each time it is administered and completely covers the skill being measured.

"It is time for us to embrace innovation and technology and bring the multiple choice question into the 21st century where it can evolve to address our current needs, and proactively tackle the problems of the future."

Dave Foster
Ph.D., Caveon Chairman & CEO

THE
Evolution OF THE
SmartItem

Technology is born from societal needs. It should adapt as those needs change.

Of all the technology introduced at the beginning of the 20th century, very few innovations have remained unchanged. You didn't take your last conference call on a wall-mounted phone, and you surely didn't commute to your last business meeting in a Model T or a Wright-Brothers-era aircraft. Technology is born from a societal need, and it adapts as those needs change.

In the assessment industry, one of our most groundbreaking innovations was the multiple-choice item, born in 1914 out of a life-or-death need for standardized measurement. However, over the past century, our needs have changed. Issues such as security, unfairness, and ballooning costs now plague testing programs and undermine the validity of their exams. It's imperative that the multiple-choice item evolve to meet these needs.

Introducing: the SmartItem

SmartItems - Designing the Future of Testing

Imagine a world where cheating on tests is impossible. This is a world in which a hiring manager can put complete trust in the test scores of prospective employees. It's a world in which students can confidently succeed in college. It's a world in which students from other cultures, who speak other languages, can demonstrate their skills on a level playing field. Imagine a world in which each person can learn at his or her own pace, demonstrating their skills using assessments that are fair, protected, convenient, low-cost, accessible, repeatable, and valid. **The SmartItem can bring about these changes and more**.

In a post-SmartItem world, you'll experience:

Increased:

- Score validity
- Accessibility
- Convenience
- Media & stakeholder respect
- Prosperity for educators
- Opportunities for honest, deserving people

Decreased:

- Fraud, cheating, and deceit
- Expenses
- Overhead
- Mistrust in assessments
- Opportunities for dishonest, undeserving people

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The Benefits of the SmartItem

The testing industry faces a number of perennial challenges. The solution? Smart design with SmartItems.

TEST INDUSTRY CHALLENGES	SMARTITEM SOLUTION
Test Fraud	Rather than just detecting cheating and theft after they occur, the SmartItem helps prevent them in the first place. While one of the SmartItems might be captured and shared online, it provides no useful information to other test takers, who will see different renderings of the SmartItem. With theft made useless by SmartItems, cheating through pre-knowledge becomes obsolete as well.
Testwiseness	Testwiseness is the ability of some people to use cues inherent in multiple-choice questions, to "game the test" and get a higher score. Because testwiseness affects test scores, it results in unfairness to individuals who don't or can't use those skills. Using DOMC as a SmartItem removes the negative effect of testwiseness on assessment validity.
Fairness	SmartItems can be constructed to modify themselves depending on the characteristics of the test taker. They can provide a choice of language for non-English speakers, text and audio options for the hearing impaired, item-based timing to assist pacing, etc. These on-the-fly customizations can calibrate each assessment to examinee circumstances to get a truer measure of their abilities.
Cost Barriers	Tests today are expensive to create, maintain, and administer. Unlike traditional items, a SmartItem typically only has to be created once and becomes virtually immortal, thereby saving a testing program substantial costs when it comes to re-writing and re-developing tests that have been compromised. In addition, with cheating and theft eliminated, the SmartItem reduces costs for security efforts.

How SmartItems Benefit YOUR Program

SHORT-TERM
- Fewer items to build and manage
- Easier, more interesting development process for SMEs
- Immediate reduction in risk from security threats
- Reduced security management costs
- Reduced incident management costs (investigation, litigation, public relations, etc.)
- Strengthened reputation for test security
- Reduced effect of testwiseness when DOMC is used

LONG-TERM
- Reduced item maintenance and replacement costs
- Improved test preparation process (test takers must gain knowledge and experience)
- More reliable program decision making (not affected by cheating and testwiseness)
- Tests that better fulfill your company's mission

What Makes an Item Smart?

9

Properties of SmartItems Explained

1 A SmartItem is an Item.

A SmartItem is created by subject matter experts (SMEs), stored in an "item bank," and evaluated with expert review. Like traditional items, it can be used with any kind of test design, such as linear test forms, computerized adaptive exams, linear-on-the-fly forms, etc. It functions in the same context as a "traditional" item.

2 A SmartItem is completely congruent with the breadth and depth of a skill.

A SmartItem must completely cover all important, stated aspects of a skill description. This property allows teachers, parents, students, administrators, legislators, and others to trust that students will be exposed to and measured on the skills that are clearly agreed upon by all stakeholders.

3 A single SmartItem can render in millions of ways.

Test security threats related to item harvesting are neutralized if a test taker is unable to predict what she or he will see when the test is taken. A single SmartItem created for a single skill can render in hundreds, thousands, or even millions of ways. Variables include:

- Changing one or more areas of content in the item stem
- Changing the response format or item type
- Changing the nouns, adjectives, verbs, images, passages, tables, and any other part of the stem
- And if the item format is selected-response, then these can also change:
  - Number of correct options shown
  - Number of incorrect options shown
  - Number of answers in the option pool
  - Number of total answer options shown
  - Order of option presentation

4 Code can be used to create a SmartItem, but it is not the only way.

Code can be used to program an item that renders in the ways necessary to cover the identified skill. When the SmartItem is presented to a test taker during an exam, running the code begins. The other way to create a SmartItem is with a preponderance of options, rather than using code. The constellations of options would be available just prior to the presentation of the SmartItem, providing a random set of them pulled from both correct and incorrect option pools. These methods (with and without code) can be used together or separately within the same item.

5 The same SmartItem looks different to each test taker.

The SmartItem design is intended to change many characteristics of items, randomly, within the strata set by each assessment objective, so each test taker will see a different version or rendering of the same item.

6 The purpose of the SmartItem is NOT to generate traditional items.

SmartItems and Automated Item Generation (AIG) differ in dozens of ways. The goal of the SmartItem, unlike AIG, is NOT to generate other items. The SmartItem actually contracts the size of item banks. These differences and many others can be viewed in our ebook *SmartItem™: Stop Test Fraud, Improve Fairness, and Upgrade the Way You Test*.

7 A SmartItem renders using "constrained randomization."

Randomization of content allows the SmartItem to render in unpredictable ways, but it does so within the constraint of the domain of the skill being measured. This constrained, or stratified, randomization ensures that each skill the test covers is represented as part of the test according to the test design. The randomization means that test takers have no choice but to prepare across the entire breadth and depth of a described skill, because the specific content measured within that skill will be unpredictable.

8 The SmartItem is not a specific item type. It is a treatment for any item type.

SmartItem technology must be applied to an existing item format, such as short answer, multiple choice, DOMC, Build List, etc., in order to work. The SmartItem can use text, audio, video, animation and simulations files as needed.

9 SmartItems can be enhanced by the DOMC item format.

The SmartItem solves two testing problems at the same time when combined with the DOMC item format instead of the traditional MC format. First, it stops forms of test fraud such as the theft of items and cheating. Second, paired with DOMC, it can eliminate most cues used by individuals who are testwise. Testwiseness, a large and acknowledged source of error, unfairly adds a few percentage points to a testwise person's score. Other test takers remain disadvantaged.

SmartItem Examples

This basic example of a SmartItem will walk you through the concept.

Objective: Know the order of the planets from the sun

Audience: General Audience / Trivia

Traditional Items

In traditional exam development, the writer creates a select number of items per the learning objective as stipulated by the blueprint. The writer chooses which pieces of the skill to measure—in this instance, which planets to test on. The final product might look something like these two items:

Which planet is second from the sun?

Earth
Saturn
Mercury
Venus

Which planet is third from the sun?

Earth
Saturn
Mercury
Venus

The SmartItem

In contrast, a SmartItem is created within a computerized tool to encompass the entire objective, not just a piece of it. Here's what the scaffolding of the SmartItem for this objective could look like:

Is this the first, second, third, fourth, fifth, sixth, seventh, eighth planet from the sun?

The computer will select from this list, at random, upon delivery.

One candidate may see "Is this the first planet from the sun?"; another may see "Is this the third planet from the sun?", and so on.

The correct option is dependent upon which list item is presented to the candidate. If "third" appears in the stem, "Earth" is the correct option. For example, the incorrect options will be any planet in the solar system that is not the correct option and are also presented at random. The examinee will see:

Is this the third planet from the sun?

Venus

| Yes | No |

To see example SmartItems, please visit these links:

K-12 Education SmartItems

Common Core ELA:
examples.caveon.com/common-core-ela

Objective: Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Common Core Math:
examples.caveon.com/common-core-math

Objective: Determine the unknown whole number in a multiplication or division equation relating three whole numbers.

Question on the Periodic Table:
examples.caveon.com/periodic-table

Objective: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.

Higher Education SmartItems

Research Methods:
examples.caveon.com/research-methods

Objective: The student will identify all main points of an introductory psychology chapter on Research Methods.

U.S. Constitution and Bill of Rights:
examples.caveon.com/us-constitution

Objective: Explain how civil liberties and civil rights are protected in the U.S. Constitution and Bill of Rights.

Certification SmartItems

Maintenance of Medical Certification:
examples.caveon.com/medical

Objective: Read and understand details of published scientific research.

IT Certification: Docker
examples.caveon.com/docker

Objective: Use the docker run command to start containers according to various requirements.

IT Certification: Oracle
examples.caveon.com/oracle

Objective: Define the scopes of variables.

Other SmartItems

National Anthems:
examples.caveon.com/national-anthems

Objective: Listen and identify national anthems from countries around the world.

Weather Map Interpretation:
examples.caveon.com/weather-map

Objective: Correctly interpret information provided on a weather map.

Bones Identification:
examples.caveon.com/bones

Objective: Identify bones of the body.

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Implementing a SmartItem

So you are interested in SmartItems, now what? Here are 4 things to consider:

What are the Software Requirements?	Using SmartItems is surprisingly easy if you are using Caveon's item development tool (Scorpion) and Caveon's secure testing tool (SEI). If you use other sysyems for item development and test administrations, we created an integration tool, called the SmartItem API. This API quickly and easily integrates with your existing systems and brings the capability and benefits of the SmartItem to you without changing your testing infrastructure.
To Code or Not to Code?	There are two general choices for item writers: design items that require code or design items that don't. Item developers need to evaluate each skill or objective and determine whether code is needed. Some objectives are better measured by simply increasing the number of options rather than producing code.
Do SMEs like SmartItems?	Creating a SmartItem is more of a design task than a writing task. SMEs read the skill description and then figure out how to design a single item to cover the entire skill. Amazingly, a SmartItem is not as difficult, nor as time-consuming to create, as you might think. In fact, if a development project calls for more than one traditional item for a skill, it might actually be easier to create a SmartItem than traditional items.
How are Cutscores Set?	Not being able to review items in the "traditional" way poses a challenge to some standard setting procedures. For example, an Angoff requires that someone read the item and then judge its difficulty. Because SmartItems constantly render unique views of a SmartItem, the review procedure needs to be adapted. The Contrasting Groups methods as well as modified versions of the Angoff have been successful.

caveon
SmartItem API

Caveon has created an integration tool that quickly and easily integrates SmartItems with your existing systems—without changing your testing infrastructure.
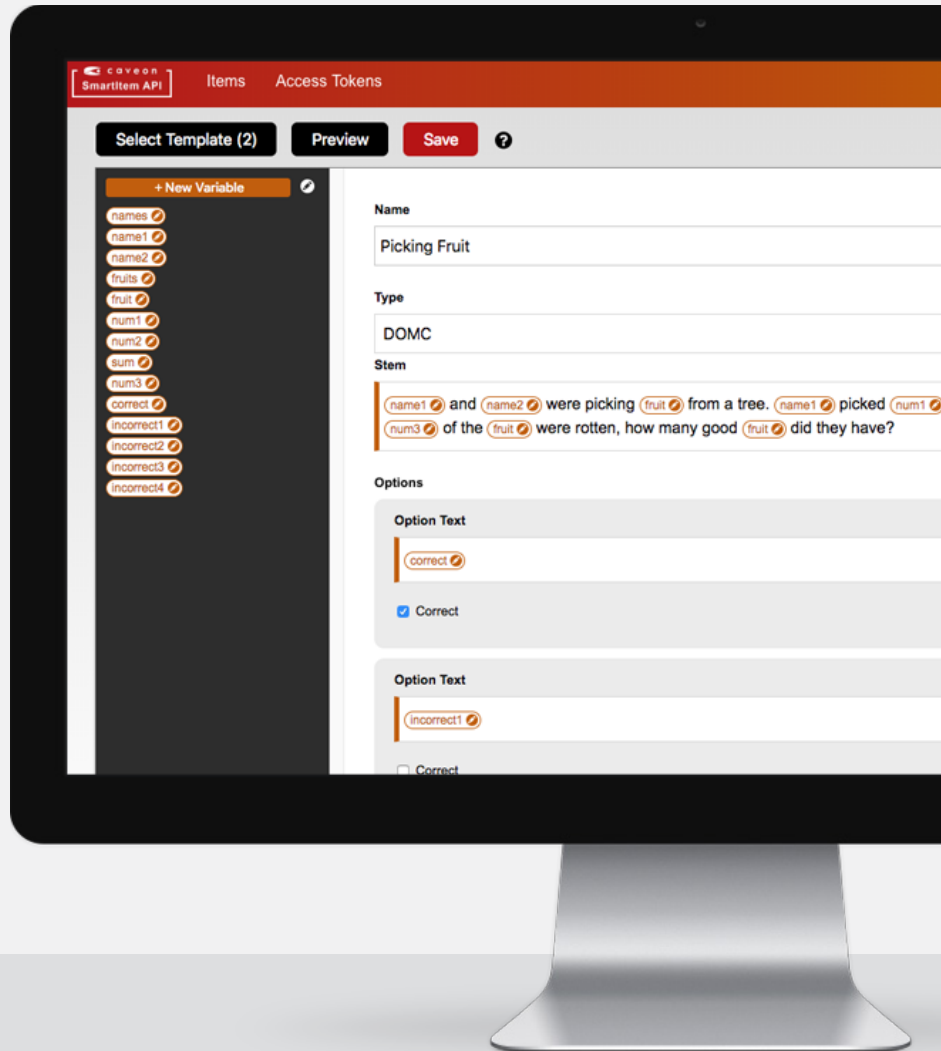
No Coding Experience Required

Create SmartItems with this powerful and embeddable editor—No coding experience required! The SmartItem API is a GUI interface that makes it easy for a SME/item writer to produce code without actually writing code. By designing the variables needed and creating lists of item components, a SME can combine it all into a SmartItem in an easy way using the API. You can even customize colors to match your item development tools.

Deliver SmartItems Natively

When implemented, the API helps your item writers create SmartItems out of any of the item types currently supported by your systems. Custom item templates support any item type, in any format, with no interruptions to test takers.

smart.caveon.com

Creating a SmartItem

In many ways, SmartItem development is very similar to traditional item development. But there are a few key differences that set SmartItems apart:

Design:

In traditional exam development, objectives are created and are weighted to determine the number of items needed. The SmartItem, unlike traditional items, leans more heavily on design than on writing. Not only does the design of a SmartItem keep it secure, but it also allows just a single item to cover the depth and breadth of an entire skill.

Development:

Using special computer technology, SmartItem writers produce one item per each objective, and ensure that the item covers the objective completely. They enter the content into the computer system by creating stems and options, with variables. These stems, options, and variables are then reviewed. A quality assurance step is added to ensure the SmartItem is functioning properly once it is in its final state.

Calibrate:

Like traditional items, you can set a cutscore for a SmartItem using various methods, including Contrasting Groups Studies and IIT-based Modified Angoff.

Monitoring:

Studies in some testing programs have shown that entire exams are often leaked to "braindump" sites as quickly as three weeks after publication. The SmartItem, by design, is immune to many threats that make content vulnerable to theft and cheating. By using SmartItems, exam programs will not need to replace exams as often, if ever.

Does the SmartItem Work?

Research Shows It Does
Our goal is to provide the information you need to make evidence-based decisions. Curious how SmartItems perform? What the item statistics are like? Whether they contribute to the reliability and validity of a test? After two case studies, three scientific experiments, and one simulation…we've got answers.

Validity:
Our research shows that the SmartItem supports and provides evidence for the valid use of test scores.

Reliability:
Research indicates that tests comprised totally of SmartItems have high reliability coefficients.

Fairness:
Research shows that by making cheating more difficult and eliminating testwiseness, SmartItems contribute to the fairness of exams more than traditional items.

To learn more about these research initiatives, please read Caveon's in-depth book, *SmartItem™: Stop Test Fraud, Improve Fairness, and Upgrade the Way You Test*.

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The
SmartItem
in Action

SailPoint

SailPoint is a leader in identity governance, which plays a critical role in modern enterprise security.

One of SailPoint's core values is "Innovation," or developing creative solutions to real challenges.

This past year, SailPoint teamed up with Caveon to do just that. SailPoint certification program staff had been aware that IT certification programs can have their exams stolen within days of being released, and the organization wanted to ensure that any certification exams bearing its imprimatur would be as secure as the available testing technology would permit.

Therefore in 2018, in its first certification program ever, SailPoint decided to use the Caveon SmartItem for 100% of each exam.

What we Learned:

Development

- We learned that SmartItems can be congruent with and built to very complex SailPoint objectives.
- We learned that the most important SME task isn't to write items, but to design SmartItems to completely cover the objectives.
- We learned that SailPoint SMEs, working in small teams, were able to utilize coders and technology to create SmartItems efficiently.
- We learned that SailPoint SMEs (who were all novice item writers), enjoyed writing SmartItems because **the SmartItem affords more creative alternatives for covering objectives**, for instance, enabling as many correct options and incorrect options as needed to cover a given item. Item authors could follow the subject matter wherever it took them. **This was fun!**
- We learned that the SmartItem authoring tools would need correspondingly-functional item review capability, to enable authors to more quickly, yet fully, check item content and design.
- We learned that, despite the newness of the SmartItem approach, it took about the same amount of overall time and effort to create SmartItems as it would have taken to create traditional items.

Field Testing

- We learned that, using established psychometric standards, **the SmartItem performs as well as—or better than— traditional items**.
- We learned that SmartItems contribute to the high reliability of SailPoint exams.
- We learned that the SmartItem contributes to the gathering of evidence for the valid use of test scores for the SailPoint exams.
- We learned that we could create pass/fail cutscores easily for tests using SmartItems.
- We learned, in general, that **there is no psychometric reason to not use SmartItems** in exams.

After developing and testing Sailpoint's SmartItems, we confirmed the promised benefits of the SmartItem, including **stellar protection, reduced costs, psychometric quality**, and more appropriate candidate preparation. Due to the very positive experiences from 2018, Sailpoint has begun developing a third exam using SmartItems, which is expected to be released in the first half of 2019.

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Is the SmartItem Fair?

Question

The issue of fairness is an important one. The SmartItem renders on-the-fly during the test, meaning one individual could get an easy variation, while another individual taking the same test could get a more difficult variation. How is that fair?

Answer

While it is true that the SmartItem is designed to vary between test takers, SmartItems are in fact fair for individuals whose test scores are being compared for two reasons:

1. **The SmartItem Relies on Randomization:** The error introduced to a test by the randomization in SmartItems is random error. The principles of science and measurement tell us that random error balances out with more items. Therefore, test scores from sufficiently long tests are comparable.

2. **The SmartItem Eliminates Systematic Unfairness:** While SmartItems add some random error to a test, they eliminate large sources of confounding or bias error from cheating and testwiseness. The trade-off is worth it.

"SmartItems are invulnerable to theft and cheating, relieving SailPoint of the same security concerns that have plagued every other IT certification program for the past three decades."

Arthur Altman
Program Manager
Global Education Services
SailPoint Technologies Holdings

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