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Rasch Modeling: Computer Assistive Technology In A High School Special Education Classroom

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RASCH MODELING: COMPUTER ASSISTIVE TECHNOLOGY IN A HIGH SCHOOL SPECIAL EDUCATION CLASSROOM

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Special education research literature reflects the gradual realization over the past decade that academic difficulties experienced by students with learning disabilities in elementary and secondary settings persist into adulthood (Chesler, 1982: Gerber, 1990: Hoffman, 1987; Johnson, 1987; White, 1982)**.** More than 100,000 Michigan students with LDs exit high school every year (Office of Special Education Programs, 1992) and 67 percent of them have plans to attend post secondary institutions (White, 1982).

Gajria, Jitendra, Sood and Sacks (2007) stated the education challenge when they wrote "many content area textbooks are often written beyond students' grade level reading ability and lack clear organization". To compound the problem, students with learning disabilities have severe problems in comprehending text. Spring (1992) and Warren & Fitzgerald (1997) suggested that a general characteristics of the student with a learning disability has poor recall of textual ideas, Baumann (1984) suggested that LD students have problems with identifying main ideas and supporting details, Williams (1993) suggested LD students often ignore extraneous information, Holmes (1985) suggested that LD students do not consistently relate new information to prior knowledge, Wong (1994) suggested that LD students do not actively monitor their comprehension. Englert & Thomas (1987) summarized the LD student's difficulties when they stated that, "LD students experience difficulty in understanding expository text patterns and using text structure knowledge to foster encoding and retrieval of content area information". Characterized as passive readers (Torgesen, 1982), students with learning disabilities come to teachers, lacking or failing to activate reading comprehension strategies to access information in textual material and, typically, do not monitor and evaluate their understanding of text. If the average learning disability student in a ninth grade American History class has reading comprehension problems, reads at a third grade reading level, and the textbook is at twelfth grade readability as determined by the Flesh-Kincaid 2005 readability formula, then without assistance it becomes very difficult for them to pass the class.

Gajria et al (2007) delineated the assistance given to students with learning disabilities into two categories: (1) content enhancement and (2) cognitive strategy instruction. The first, content enhancement, included; semantic mapping (Bos & Anders,1990), semantic feature analysis (Bos, Anders, Filip, & Jaffe, 1989), advance organizer (Darch & Carnine, 1986), visual display (Darch & Eaves, 1986), visual-spatial (Darch & Gersten, 1986), display graphic organizer (DiCecco & Gleason, 2002, Griffin, Simmons, & Kame'enui, 1991), mnemonic illustration (Brigham, Scruggs, & Mastropien, 1995, Mastropieri, Scruggs, & Levin, 1987, Scruggs), and CAI/Multimedia (Okolo & Ferretti, 1996), with CAI/multimedia having the lowest effect size of .21.

The second instructional approach, cognitive strategy instruction included; text structure (Bakken, Mastropieri, & Scruggs, 1997, Smith & Friend, 1986), cognitive mapping (Boyle1996, 2000), paragraph restatement (Bakken, Mastropieri, & Scruggs, 1997), identifying main idea (Graves, 1986), main idea, self monitoring (Graves & Levin, 1989), mnemonic technique (Graves & Levin, 1989), paraphrasing (Ellis & Graves, 1990), summarization (Gajria & Salvia, 1992, Malone & Mastropieri, 1992), elaborative interrogation (Mastropieri, Scruggs, Hamilton, Wolfe, Whedon, Canevaro, 1996), critical thinking skills (Darch & Kame'enui 1987), self-questioning (Wong & Jones, 1982) and question-answer relationship (Simmonds, 1992), with question-answer relationship having an effect size of 1.53. Instruction in reading comprehension has been the focus of research over the last 30 years. Students with learning disabilities still need support answering comprehension questions on a daily basis in the classroom. Specifically, LD students have difficulty answering comprehension questions from history books. The expository text of the History differs in its structure, vocabulary, and difficulty level from narrative prose (Gajra et al, 2007). The special education student in a history class needs assistance comprehending the textbook. The assistance administered in this study will be the combination of study guides and computerized speech. The Rasch model will measure using study guides with assistive technology – computerized speech.

The Rasch Modeling

Rasch developed a model to evaluate one aspect of reading ability on the basis of the number of a student's "misreading" on an oral reading test. In the Rasch study students were presented a text that was read aloud, and a record was made of the number of words misread. It was assumed that the student's probability of misreading any word was a small constant depending on the student but not on the particular word, and that the probabilities were independent over words for a given student. From these assumptions, Rasch derived a Poisson distribution for the number of misreadings as a model.

The Rasch model is regarded as a special case of item response theory (IRT). Cohen (2008) explained how the Rasch model is a special form of IRT. First Cohen described the Rasch model algebraically by asking the reader to suppose that if there are a total of *j* items available, with a difficulty parameter b_j for each item *j* and the ith person's response to the *j*th item is z_{ij}, and to assume that:

1. θ_i represents examinee *i*'s true ability on the latent trait, usually the person's ability,
2. $f(\theta)$ is the distribution associated with the latent trait, and
3. $f(\theta)$ has finite moments.

Then, if item responses were continuous variables, they could be described by the linear model

$y_{ij} = \theta_i + e_{ij}$ where y_{ij} is person *i*'s unobserved response to item *j*, and e_{ij} is the individual and item-specific measurement error in the response.

If item responses are binary measures, instead of y_{ij}, let $z = \begin{cases} 1 & if\ y_{ij} > b_j \\ 0 & otherwise \end{cases}$, where b_j is a threshold along the true-score dimension. The relationship between ability and item response can be stated as a probability**:**

$$p\left(z_{ij} = {}^{1}/_{\theta_i}\right) = p(\theta_i + e_{ij} > b_j)$$
$$= p(-e_{ij} < \theta_i - b_j)$$

Cohen (2008) stated that this relationship forms the basis of most models from item response theory (IRT), of which the Rasch model is a special case. In the standard Rasch model, the distribution of the measurement error takes a logistic form (Rasch, 1961):

$$p\left(z_{ij} = {}^{1}/_{\theta_i}\right) = \frac{1}{1 + e^{-(\theta_i - b_j)}}$$

Specifically, the Rasch model provides a basis and justification for obtaining person locations on a continuum from total scores on assessments. Total scores are often treated as measurements, but with the Rasch model, total scores are actually counts of discrete observations rather than measurements. Each observation represents the observable outcome of a comparison between a person and item. Masters and Wright (1984) stated that the scores from which items are calibrated and persons are measured are never more complicated than simple counts of objectively defined events.

The Problem

The purpose of this study was to use the Rasch Model to evaluate the effectiveness of using study guides with speech synthesis to compensate for reading deficits with learning disabled students in an urban high school. The Rasch Model used in this study measured the ability of students to answer comprehension questions for a history course. The Rasch model is a two-parameter model with one parameter the ability of the person, and the second parameter the difficulty of the item. First, the study determined the reliability and quality of the study guide. Secondly, this study used the Rasch model to determine if a special education student's ability to answer questions changes with the assistance of assistive technology.

In this study the Rasch model was used to determine reliability and quality of the measurement instrument. Specifically, the Rasch model was the tool used to assess the quality of the study guides used by the classroom teacher. The major emphasis of the study was to use the Rasch model to provide useful information for structuring study guides for special education students.

The unique ability of the Rasch model to separate student ability and item difficulty seemed to make it a good fit for assessing special education student's ability to answer context questions. Special education students are expected to complete daily classroom assignments using the same class materials as regular education students. Students reading at pre-primer, first and second grade are expected to answer questions from textbooks with ninth, tenth or eleventh grade readability. At the time of the study, the consensus of thought among special education teachers at the high school level was that if the school district had not corrected the reading deficit by ninth grade, then the secondary settings (high schools) should provide services and suggest strategies designed to compensate for – rather than correct – disabilities. It seemed supervisors expected utilization of technology in the classroom; they monitored staff using Classroom Visitation forms that asked whether the teacher was using low/high technology to access the curriculum. If teachers are asked to use assistive technology in the classroom they need to know what works. Specifically, teachers must implement “best practice” based on research. The question becomes, “Can the Rasch model be able to provide informative information to produce effective study guides for a special education classroom using assistive technology?”

Purpose of the study

The purpose of this study was to use an assessment procedure to evaluate implementing assistive computer technology in an urban high school to support learning disabled students’ ability to answer study guide questions for United States history. The technology to be used was speech synthesis which allowed students and teachers to input text into the computer that could then be read by a speech synthesis/screen review program that simultaneously outputs digitized speech and highlights the text on the screen. Also, a study guide for each chapter was provided. The study guide contained questions that mirrored the content of the text. The questions were formatted both in print form and as synthesized speech on the computer. The Rasch measurement model was used as the assessment to: (1) determine the quality of the study guide, and (2) try to capture the change in question answering ability of learning disabled students.

Research Question

1. Can the Rasch model: (1) assess the reliability and validity of the study guide questions, and (2) estimate student ability to answer criteria referenced study guide test questions?
2. Is there an improvement in ability to answer study guide questions for a special education student using assistive technology?

Limitations

Several threats to the study were apparent and are summarized below:

1. The study participants were students assigned to a classroom. Because of this lack of randomization, generalizibility may have been compromised, and

2. The study group was small. Fifteen students were assigned to the technology classroom and four students were assigned to use the computer. This may have affected the power of the statistical test used to analyze the data.
3. There was a high possibility of extreme data on the study guides (the measurement instruments) due to students often: guessing, rushing through assignments, or only answering easy questions. The resulting behavior may have produced extreme data that may have affected the power of the Rasch model.

Assumption

The ability to answer the study guide questions was defined as reading comprehension. Reading comprehension and ability to answer study guide questions was assumed to be the same concept. The term “ability to answer study guide questions” was used in this study.

Intelligence, stimulation and motivation have been the focus of previous research related to assistive technology (Anderson-Inman, 1996). These variables have been a source of variance in the dependent variables, but were not included in statistical analyses to address the research questions developed for this study.

Important Terms

Student with a disability.

‘Student with a disability’ was defined as a person who is determined by an individualized education program team or a hearing officer to have one (1) or more impairments that necessitates special education or related services, or both: is not more than 25 years of age as of September 1 of the school year of enrollment: has not completed a normal course of study, and who has not graduated from high school” (Services, 2002).

Specific Learning Disabled.

'Specific learning disability' was defined as a disorder in one (1) or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or to do mathematical calculations. The term included such conditions as perceptual impairments, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia" (Services, 2002, p, 6).

Cognitive Impaired.

Cognitive impairment was defined as a condition manifested during the developmental period and determined through the demonstration of all of the following behavioral characteristics: (a) Development at a rate at or below approximately two (2) standard deviations below the mean as determined through intellectual assessment, (b) Scores approximately within the lowest six (6) percentiles on a standardized test in reading and arithmetic, (c) Lack of development primarily in the cognitive domain, (d) Impairment of adaptive behavior, and (e) Adverse affects upon a student's educational performance" (Services, 2002, p.3).

Emotionally Impaired.

Emotional impairment was defined as a condition determined through manifestation of behavioral problems primarily in the affective domain, over an extended period of time, which adversely affect the student's education to the extent that the student cannot profit from learning experiences without special education support" (Services, 2002, p.3).

Assistive Technology.

‘Assistive technology’ consisted of Pentium/ 150 MHz personal computers utilizing the software *Write Out Loud.* This technology enabled students to use the computer to pronounce words of their textbook.

Rasch measurement model.

Ability change was measured using the dichotomous Rasch model to count individual student’s events of answering a daily classroom study guide.

Review of the Literature

This study was conducted to explore how disabled high school students can be evaluated to get a more concise picture of academic improvement when using assistive technology. Also, studied was how using a study guide affected the ability to answer questions related to the text of a required U. S. history book. Answering comprehension questions is a fundamental task for school success (Haberman, 2003). The act of the teacher asking questions and the student answering is a very important activity in the classroom. At the time of the study, students had to master daily assignments or classroom tests with seventy (70) percent accuracy to pass most high school classes. This chapter provides a context in which to consider the relevance of using questions in the classroom. The historical development of special education and assistive technology will be presented, with the evaluation research of special education assistive technology summarized. This will be followed by a review of the Rasch model and a review of using questions as a study guide to increase retention.

Stiggins (2002) stated that the feedback to the questions teachers ask provide the moment-to-moment, day-to-day, and week-to-week instructional decisions necessary to implement and manage the learning process in the classroom. The teacher questions can diagnose student needs during learning and tell students what study tactics are working or not working (Stiggins, 2002). Black and Wiliam (1998) asked if improved formative assessments (teacher questions) yield higher student achievement as reflected in summative assessments? If so, they asked, what kinds of improvements in classroom assessment practice are likely to yield the greatest gains in achievement?

Black and Wiliam (1998) synthesized more than 250 articles that addressed the classroom assessment issue. Only several dozen articles addressed the question of the impact on student learning utilizing experimental control. Black and Wiliam pooled the information of these studies and estimated the effects of improved formative assessment on summative test scores. They reported positive effect sizes of one-half to a full standard deviation on student achievement. Furthermore, Black and Wiliam reported that improved formative assessment can help low achievement overall (Black & Wiliam, 1998). The study suggested that, if the teacher provides good formative assessment (questions), then the student should answer like questions well on standardized tests. The logic followed that if good questions are asked during the reading of a textbook, the student should answer the same questions well on the classroom tests.

The Education for All Handicapped Children Act mandated that all disabled children be given an equal opportunity to succeed in the regular classroom. If success in the classroom is achieved by reading and by answering comprehension questions on daily assignments, then students with Learning Disabilities have a disadvantage. Students with Learning Disabilities (LD) are placed in the regular classroom with severe reading deficits. Grade level books become a barrier to successfully read and answer comprehension questions for students with a reading deficit. For approximately eighty thousand (80,000) learning disabled students nationwide, it is the school's responsibility to facilitate educational success.

Legislators passed amendments to the Individuals with Disabilities Education Act (IDEA) that allowed students to use assistive technological devices in the classroom. The IDEA amendments of 1997 defined an assistive technology device as "any piece of equipment, or product system that is used to increase, maintain, or improve functional capabilities of individuals with disabilities": (Part A, Sec 6022 [1]).

In the 1970s, the U. S. government passed legislation entitled the Education for All Handicapped Children Act (EAHCA). For the first time, all school districts across the nation were required by law to design, to develop and to implement comprehensive educational programs for handicapped students. The major focus of the legislation was to place eight million handicapped children into the educational system (Alexander, 1992). As special education programs developed, educational software and adaptive devices were developed for use with handicapped students.

Unfortunately, computer assistive devices were not specifically developed for students with learning disabilities. The computer devices developed were solely for students with vision, hearing loss or paraplegia (Higgins, 1995). During the 1970's schools developed intensive remedial reading and writing programs (Blalock, 1981; Cordoni, 1979; Vogal, 1982). However, no specific computer assistive hardware or software was developed in the 70's or 80's specifically to help students with learning disabilities read and write**.**

Research during the 1970s compared the effectiveness of teacher versus computer instruction. After an extensive review of the technology studies, Clark (1994), determined there was no difference between computer and traditional teacher based learning. Clark stated that "learning is not caused by the technology but by the instructional method …"embedded in the media" (Clark, 1994, p.22). "Technology is "merely a means of delivering instruction," he said. "a delivery truck, so to speak, that does not influence achievement". Russell (1999) showed the same results. Russell (1999) stated, "No matter how it is produced, how it is delivered, whether or not it is interactive, low-tech or high-tech, students learn equally well". Morrison (2001) remarked, "if you try to compare media, you have to keep the instruction constant. If you keep it constant, and the medium does not change the message/instruction, you will find no significant difference."

Conversely, in the nineties, Kozma (1994) stated that “separation of media from method creates an unnecessary and undesirable schism” and that “both medium and methods influence learning and they frequently do it by influencing each other”. Agreeing with Kozma, Smith and Dillon (1999) suggested a “media/method confound” or an inability to separate technology from the way it is used in instruction. They went further to suggest that the reason for the “no significant difference” in comparison studies was simply the inability to truly separate technology from instruction. They took the view that both medium and methods influence learning.

The research of the seventies did enlighten educators to the fact that the computer alone would not be the “cure” for learning disability. Many educators realized that computers were not a cure, but they held to the belief that computer based learning could affect learning disabilities. Research continued to evaluate computer instruction with special education. In the next decade researchers began to question what specific capabilities of the computer would impact what specific learning disabilities.

Fundamental to evaluation was the problem of how to assess the abilities of students with significant disabilities. Browder et al. (2004) tracked the shift in assessment focus for students with significant disabilities over the past 30 years. They noted four major phases of intervention research and its impact on assessment. Initially (in the late 1960’s), programs were aligned with infant and early childhood developmental theories using age-based norm. The second phase in the late 1970s focused on functional curricula with four major domains: vocational, community, recreational, and school. A third phase appeared in the 1990s combining this functional approach (and complementing community and school access) with more school based tasks to address self-determination (Browder, 2002).

During the 1960s, a movement began in Denmark to measure school-based tasks for disabled students. Specifically, Rasch (1960), developed models to measure reading ability that could be applied to students with disabilities. Rasch, developed his approach as an alternative to national standardized testing. He developed probabilistic models in which the role of the population could be abolished. Therefore, statistical tools such as correlation coefficients, regression analysis, analysis of variance, factor analysis, etc, were not used in his investigations.

Rasch's models implied two types of parameters: a "difficulty" for each test (or item) and an "ability" for each person. The response to the test questions became random. Rasch stated, "The "ability" of each person has to be estimated from the results of the tests applied to him, but the estimation procedure yields a result that is independent of which particular set of tests (or items) has been employed." (Rasch, 1960, p. 3). Although a variety of "Rasch" measurement models appeared in the literature and were widely discussed (Andersen, 1973, 1980; Fisher, 1973; Rasch, 1960, 1961,1977; Wright, 1968, 1977,1983). The U. S. special education community did not adopt the "Rasch" measurement models as a form of alternate assessment.

1980s

Lewis (2000) referred to the 1980s as the "feasibility years", many studies demonstrated that students with learning disabilities were able to learn with the use of technology (Lewis, 2000). One effort to study the use of technology compensating for reading deficits of the learning disabled was at the Learning Disabilities Program at California State University (CSU). CSU was the first institution of higher learning to actively pursue utilizing assistive technology with secondary and post secondary learning disabled students. Higgins (1995) suggested that the proximity of CSU's Learning Disabilities Program to its Computer Access Laboratory provided the environment for CSU staff to experiment with assistive technology already developed for other types of disabilities. The staff used assistive technology with students diagnosed as learning disabled (Higgins, 1995). CSU specialists pioneered the student's simple technologies, such as using variable-speed tape recorders to record lectures or assignments, talking calculators and held-held spellcheckers plus listening to books on tape.

Computer technologies came to include word processing, organizing programs, spell-checkers and grammar checkers. Students with below average achievement in reading comprehension were introduced to optical character recognition and speech synthesis programs so that difficult material could be scanned in and read back to them. The CSU center conducted a research study on postsecondary students with LD using optical character recognition with speech. Researchers concluded that students with below average scores in reading benefited from use of the technology while the above average students showed an interference effect (Higgins, 1995).

Twenty years later, Clark and Mayer (2008) stated that there were major exceptions to the redundancy principle. He stated that "the major exception to the redundancy principle occur in special situations in which on-screen text either does not add to the learner's processing demands or actually diminishes them … consider what happens in the learner's cognitive system when you use redundant on-screen text, for example, presented as text on a computer screen using the same words as the narration. In this case, spoken words enter through the ears and text words enter through the eyes, so neither channel is overloaded." (Clark and Mayer, 2008, pp. 126-127) He explained that when there are no graphics with the text, the spoken words enter through the ears and text words enter through the eyes, so neither channel is overloaded when processed in the brain. Research by Moreno and Mayer (2002) showed that in certain situations learners generated approximately three times as many correct answers on a problem-solving transfer test from presentations containing concurrent spoken and printed text than from spoken text alone.

Other researchers of this era, Torgesen, and Sexton (1987) found that after about 10 hours of practice, students with learning disabilities improved on both speed and accuracy of word decoding and reading using computerized speech feedback . The results of Torgesen were supported by Roth and Beck (1987). Roth and Beck found that students with reading disabilities tested one year higher relative to a control group of disabled readers who had not received instruction with computerized speech feedback.

Horton, Lovitt, Givens and Nelson (1989) researched the effects of using a computerized study guide for remedial and learning disabled ninth graders in a regular education world geography class.

Horton found that students that read text from the computer and used a questioning study guide performed better on corresponding criterion tests (Horton, 1989). Several studies found that students with learning disabilities improved on both speed and accuracy of word decoding and reading when utilizing computerized speech feedback (Torgesen, 1995; Roth, 1987). These programs utilized two types of feedback: “whole-word” and “segmented word” feedback. Van Daal and Ritsma (1990) found equally high learning results with both forms of speech feedback – “whole-word” and “segmented word” (Van Deal, 1990).

The focus of research during the beginning of the 1980s was with the use of assistive technology to help postsecondary students both compensate and circumvent, their difficulties. During the later part of the eighties, the focus of assistive technology research shifted from “compensate for deficits” to “remediate deficits”. There were numerous applications of remedial software used with children and adolescents with learning disabilities (Chiang, 1981; Collins, 1990; Jones, 1987; Leong, 1992; Lundberg, 1986; Olson, 1992; Wise, 1992), there were no official standards for quality or criteria for “good” remedial educational software used with learning disabled (Larsen, 1995). Teachers did not have a master plan for the best methods, processes or procedures to implement assistive technology.

There was no master plan for technology implementation and there was no master plan for the evaluation of students with disabilities. Alternate assessment was not a viable method of evaluation in the U.S. during the 1980s. Studies tried to side step the issue of “alternative testing” by using standardized tests. For example, in the Roth and Beck study, students with learning disabilities were compared to a control group using a standardized reading test. Standardized tests did not have the expanded measurement capability to detect low functioning abilities and could not show ability growth. The label “learning disabilities” did and still does not automatically identify a homogeneous group. The range of abilities for students labeled “learning disabled” could be quite large, even within a classroom. The disabled students’ reading ability could range from low to high. Studies during this time period were limited by the lack of adequate assessments. As Ysseldyke (1997) states, “alternate assessments at this time were quite ill defined and diverse in both focus and format” (Ysseldyke, 1997).

1990s

In 1990, the Individuals with Disabilities Education Act (IDEA) ushered in Federal legislation that assured the rights of all handicapped children to the least restrictive environment (Alexander, 1992). IDEA legislated inclusion of disabled students into the public school regular education classroom. With more special students in the classroom a need arose for more direct teacher time. Technology was viewed as a cheap and effective means of providing individualized instruction for disabled students in the classroom.

The first educational computer-assisted instruction (CAI) for students with learning disabilities was developed during the nineties (MacArthur, 1995). This CAI had the look and feel of programmed learning**,** it was a linear model in which the computer was programmed to present the learner with a sequence of academic tasks that if responded to correctly allowed the learner to proceed until mastery was achieved. Specifically, the computer was used to remediate learning.   The problem was that this system did not work well in a classroom setting. The special student was removed from the class and administered the computer remediation, often spending hours in these computer labs with tutors or staff, which defeated the intent of inclusion as defined by IDEA.

Also it became evident that computer remediation could not solve many of the problems the learning disabled student had in the regular general education curriculum. Higgins (1995), explained that tutors or staff were often not available for students seeking help with long reading or writing assignments due in two or two days. Higgins stated that, “Learning disabled students needed strategies (other than remediation) that could help with reading or writing assignments”. Higgins lamented that after decades of working with learning disabled students, more than just remediation was needed to tackle the challenge of a rigorous high school or university curriculum (Higgins, 1995).

Researchers began to broaden the focus of their study of computer use for the learning disabled. Lewis R. (2000) stated that during the 1990s assistive technology shifted from Computer Assisted Instruction (CAI) to use of the computer as a tool (Lewis, 2000). Special educators wanted computers to compensate for learning deficits when used in the classroom. One example is the use of computer-based study guides to enhance acquisition of content material from books. Horton (1989) and his associates studied the use of computerized study guides for students with learning disabilities. They reported significantly higher performance by mainstreamed students with LD who used computerized study guides in a remedial world geography course than by comparable students who used a non-computerized note-taking procedure (Horton, 1989). Higgins and Boone (1990) studied the use of hypertext study guides. They reported the learning disabled students had higher retention test scores with the use of hypertext study guides (Higgins, 1990).

Wise and Olson (1994) found that disabled readers using whole words (e.g., cupcake) and syllables (e.g., cup/cake) for synthesized speech feedback with electronic stories and books helped to improve the word recognition and phonological decoding (Wise, 1992). MacArthur and Haynes (1995) found significantly higher comprehension scores when learning disabled students used an upgraded version verses a general version of Student Assistant for Learning from Text, SALT, a reading support system for the learning disabled. The upgraded version of SALT provided students with three types of support: (1) compensatory support to improve reading fluency (e.g., glossary for definitions, speech synthesis for pronunciations etc.); (2) strategic support to guide students' use of cognitive and metacognitive reading strategies; and (3) substantive support of modifications that enhance comprehension of content. (MacArthur, 1995)

Anderson-Inman (1996) studied learning disabled students using computer based study strategies. Specifically students used Inspiration 4.0 (Anderson-Inman, 1994), to take classroom notes, to develop concept-mapping, and to self-test their knowledge by expanding and contracting portions of a outline to hide or show material under headings. Anderson-Inman felt that if learning disabled students could read a text book, create a hierarchical framework, and then self test then they had "learned". Anderson-Inman found that the participants formed three types of students: (1) Power Users, (2) Prompted Users, and (3) Reluctant Users. It was suggested that "Power Users" became very skilled in using the computer strategies, Prompted Users" developed moderate skills in using the computer strategies and continued to need prompting and assistance to move beyond the basic application, and the "Reluctant Users" developed only limited knowledge of the computer study strategies and used the strategies only when under direct teacher supervision. Anderson-Inman found that intelligence, as measured by IQ tests, was positively associated with adoption level. It was also found that the amount of instruction, in use of the computer software, seemed to be positively correlated with adoption level (Anderson-Inman, 1996).

Wise and Olson (1994) suggested that students with learning disabilities have problems decoding words (making accurate sound-symbol connections), they speculated that computerized speech synthesis could help students make accurate connections. Wise and Olson rationalized that when errors occurred in reading, the student received incomplete information from the text, and comprehension was adversely affected. If synthesized speech could deliver complete information, then comprehension would be affected. Wise and Olson along with many other studies during the nineties showed a slight positive affect between computerized speech synthesis, when the computer provided feedback and guidance for difficult words, and reading comprehension (Wise, 1992).

Studies up to this point suggested that more then just speech feedback was needed to significantly improve reading comprehension. Computerized speech with strategic supports seemed to work best with compensating reading deficits with the learning disabled. In general, the studies of the 1990s shifted from instructional medium comparison studies to those that concentrated on specific conditions that affected student learning (Higgins, 1990).

The technology studies occurred in an environment where disabled students were not a part of the general education testing. IDEA ushered in a plethora of classifications for "disabled" students (i.e. cognitive impaired, learning disabled, emotionally impaired, physically impaired, and autistic). "Disabled" students were incorporated into schools, but were usually exempt from standardized testing. With different levels of student abilities labeled "disabled" schools generally had problems deciding which "best" measurement procedure to use. On a positive note, in the 1990s, alternative assessments clearly started to become oriented toward academic standards. Yovanoff and Tindall (2007) stated that three academic assessment response formats were developed for alternate assessment: portfolios, observations, and performance assessments. The above constructed response formats were evaluated (Bennett, 1993a: Messick, 1996; Thissen, 1994; Traub, 1977), and were deemed to have promise as part of statewide alternate assessment programs (Bennett, 1993b; Linn, 1995; Robinson, 1993; Thissen, 2001). Portfolios, observations and limited performance assessment evaluations were cumbersome and time consuming in the general school curriculum.

The lack of a concise test to bring the special education population up to the test standards of the general population seemed to affect the studies of this era. The technology studies did reflect the dilemma that the schools were having. For example, the Olson and Wise study used observation.

Another issue of the technology studies was the lack of "disabled" students. The Wise and Olson (1992) study of poor readers and spellers did not use students categorized as "disabled" (Wise, 1992). The technology studies often used students labeled "poor readers" by the classroom teacher. To bypass the extensive psychological testing needed to determine "disabled" students, studies used "poor readers" or "reading disabled" students.

Higgins and Zvi (1995) used post secondary students with learning disabilities as subjects. She used the Formal Reading Inventory in a post test design to compare students using speech synthesis, human reader, and no assistance. The study's findings suggested that Optical Character Recognition and Human Assistance conditions assisted students with low reading level greatly, but seemed to interfere with the performance high reading level. Higgins's study was able to sidestep the issue of the wide range of student abilities by using post secondary students. Higgins and Zvi used college bound learning disabled students with reading levels that were high enough to function in a college environment. On the other hand, Anderson-Inman's study using computer-based study strategies with learning disabled secondary students made the attempt to classify the subjects as learning disabled. The effort to classify the students seemed to outweigh the evaluation method of the study – which was observation.

Ford, Davern, and Schnorr (2001) described attempts to develop alternative performance indicators during this time period as: (a) an attempt to the simplify the regular standard until something (anything!) that the disabled student could do, or (b) redefine the regular curriculum standard so that it represented some type of functional skill (Ford, 2001). The problem was that neither option of simplifying or redefining was likely to provide a technically adequate alternate assessment**.**

2000s

Legislators ushered in No Child Left Behind legislation during the year two thousand and two. No Child Left Behind legislation held school staff accountable for their students passing standardized tests. Student progress was measured by test scores of ninety-five percent of a school's student population (both regular and special education students). Ninety-five percent of the school student population was expected to improve yearly on state standardized tests. Each year the school calculated its annual yearly performance (AYP). If AYP did not improve there were dire repercussions. The dire repercussions ranged from closure of the school to the assignment of administration and staff after the fourth year. Educators were motivated to find teaching methods or technology methods (based on sound research practices) that could affect test scores of regular education students as well as special education students. Persistent reading deficits for secondary learning disabled students became an issue in schools trying to improve their test scores yearly. Educators wanted to know what "best practices" could specifically improve the learning disabled student's reading that would translate into improved test scores.

Educators wanted to know what computer based "best practices" could improve the learning disabled student's reading. Many researchers began moving away from the suggestion that computer based instruction was "no different" from a delivery truck. Researchers such as Tuckey (1993), Burbules and Callister (2000), and Fahy (2000) proposed computer based research to determine the usefulness or appropriateness of the computer for different disciplines or learning objectives. Specifically, Tuckey proposed that "some technologies were more appropriate for visually based disciplines and other better for discourse". Burbules and Callister wanted to find "*Which* technologies have educational potential for *which* students, for *which* subject matters, and for *which* purposes?" Fahy wanted to know what was the "best media mix" to achieve different learning goals?

One of the first studies to address "best media mix" by Helgeson (1988) suggested that the most effective combination of instructional opportunities included hands-on laboratory experiences and computer simulations to improve student's scientific thinking. Dziuban and Moskal (2001) found that courses with both computer and face-to-face components produced the same or better success rates than courses that were fully on-line or face-to-face. Meyer (2002) summarized the direction of computer research as finding the optimal combination of technologies – not limited to face-to-face, interactive video and Web – that maximize learning based on the needs of the curriculum, the type of learning desired, and the learner's characteristics.

Even with sound research suggesting that digitized speech is effective in improving learning disabled students' reading comprehension many schools found that digitized speech was not practical. Rose (2001) showed that the use of digital texts with imbedded reading strategies increased reading comprehension by a half year's progress after reading three novels. On the other hand, he found that when schools digitized their own books they incurred large costs due to staggering duplication efforts (Rose, 2001).

Digitized books contained digitized text, speech, pictures and games. Lewis, R. (2000) conducted a study to investigate if students with learning disabilities would avoid the act of reading by only interacting with the Figures, not the text. Analyses revealed that students choose to spend 65% of their time engaged in non-reading activities such as interacting with hot spots in the Figures, playing arcade-type games when these were available, and pursuing other activities such as drawing, matching, and memory games. The second part of the study introduced expected performance objectives with instructional supports - where the students had segments of the digitized stories to read orally. With instructional support, student reading skills, comprehension, acquisition rate and word recognition skills increased (Lewis, 2000).

Whether the learning disabled use digitized speech with simultaneous words on the screen or digitized books with speech, text, pictures and games, the studies seem to suggest that this technology did support improved reading and reading comprehension. Digitized speech technology is currently the "assistance choice" by special educators of secondary and post secondary learning disabled students with reading deficits. Digitized speech software has improved. Not only can students instruct speech synthesis programs to read selected words, whole lines, and entire text selection, the upgraded digitized speech programs allow students to adjust font size, font color, speech speed and speech amount.

A problem is that the text must still be scanned in or typed into the computer. This typing and scanning is very time consuming. Rose (2001) states that when schools digitize their own books the duplication of effort will be staggering. Because there is no standard format, digitized books are not readily available from the publisher. The digitized format may be different for each publishing company therefore requiring a school to have hundreds of different types of software to access digital books.

Federal legislation, in 2001, did mandate a standard format for digitized textbooks. The Instructional Materials Accessibility Act of 2001 was conceived to help provide a standardized format for all textbooks and establish a distribution center for digitized books for the disabled. Specifically, this bill provides for the development of a single national electronic file format to be used by publishers corresponding to texts they publish. Additionally, the bill calls for a national electronic file repository. When digitized books become available special education educators still need to know “best” practices and procedures for effective remediation or compensation for learning disability reading deficits.

Best practice was and still is hard to ascertain without adequate assessment. The need for adequate assessment was addressed in No Child Left Behind (NCLB) legislation - with requirements that alternate assessment must align with grade level content and performance (achievement) standards.

Students started using standardized tests. For example, Rose (2001) used standardized tests of reading comprehension to study learning disabled students' use of digital text with embedded reading strategies. The Rose study reported that students achieved a half years progress after using computer reading. Jimenez (2003) used IQ tests - not to classify students, but to determine if IQ affected the results of computer-assisted practice using speech synthesis. Jimenez found that low-IQ students were more successful in improving their phonological awareness skill using the computer. Irausquin (2005) used a standardized reading test to confirm the benefits of computer presented speed training to improve word and text reading efficiency for learning disabled students. Use of standardized tests in the above studies exemplified the direction and focus of measurement and evaluation of the disabled student.

The question becomes, what evaluation procedure can most effectively measure the individual improvement of content (subject area) taking into account the ability of a disabled student? The historical review of special education legislation and technology development shows a concerted effort to integrate students with special needs in general education classes with technology support to improve ability. Through the decades, assistive technology effectiveness studies have evolved from: (1) comparing the teacher to technology, to (2) analyzing the effectiveness of specific technology attributes to specific student deficits, to (3) affecting achievement scores.

No Child Left Behind legislation has affected evaluation of the special education population. The measurement of disabled students in the classroom must now include achievement gain, thus, evaluation must be sensitive to ability level and test difficulty. In the classroom, disabled students can have a wide range of reading abilities (due to the different types of classifications). Classroom test and worksheet questions reflect state grade level content and performance standards (benchmarks) – the questions may range from easy to difficult. To measure individual achievement, in the classroom, it is necessary to measure achievement gain based on difficulty of the items as well as the ability of the student.

The Rasch Measurement Model

The Rasch Measurement Model is a type of item response theory (IRT) that measures item responses rather than total scores to identify ability level (Lord, 1980; Stocking, 1983; Thissen, 2001). Specifically, the Rasch model examines (a) examinee ability and (b) item difficulty. Yovanoff, 2007, explained that the model is based on probability, such that, if given the student's ability, as an item becomes more difficult, the probability of a correct response diminishes (Yovanoff, 2007). From another perspective, given an item's difficulty, as the student's ability increases, the probability of a correct response increases. Estimating the probability of a specific response is based on a comparison of the person's ability and the item characteristics.

The Rasch model grew out of Danish national testing. The Rasch model was developed to address the need to assess the level of attainment of a pupil independent of which test was used and independent of age, school group and time of school year. The development of the Rasch model utilized a large data base of every child in grades 3 to 7 evaluated with two tests (Rasch, G. 1960). The Rasch model was not initially used with small sample sizes such as a classroom. Subsequent researchers utilized the Rasch model with large data bases (Bond, T and Fox, M. 2001). The effectiveness of the Rasch Measurement Model to measure the ability of handicapped students to comprehend text and answer related questions when a small sample size is used was questioned in this researcher's study.

Using questions as a study guide to increase retention

Horton and Lovitt (1989) used the teaching strategy – adjacent questions in the form of computerized study guides with learning disabled students (Horton, 1989). Horton and Lovitt (1989) found that computerized study guides effectively imparted social studies material to pupils with learning disabled students (Horton, 1989). Horton and Lovitt (1989) found that computerized study guides effectively imparted social studies material to pupils with learning disabilities at the secondary level. The Horton and Lovitt study was based on thirty-one students divided into a control and experimental group, two short reading passages with questions, and a 15-item multiple choice test. Horton and Lovitt's study suggested that adjacent questions could increase retention of content material.

Using questions to ask people about what they have retained from their reading has a long history of research. One of the earliest studies, Gates (1917) suggested that substantial benefits could be achieved from "active recitation" (Gates, 1917). Jones (1923) showed that cloze-type questions asked after reading doubled scores on tests taken a day later (Jones, 1923 - 1924). Rothkopf's (1966) interspersed questions before and after text segments, helped readers retain more passage material. Rothkopf's "direct instructive effect" suggested that pre and post-questioned groups produced more recall of material than non-questioned groups (Rothkopf, 1966). Rickards (1979) suggested that both adjunct question groups retain more of the questioned material than a reading-only control group (Rickards, 1979).

Anderson and Biddle (1975) reviewed the literature related to the topic of questioning and found: (1) people correctly answered the questions on a test when the same questions were placed before of after the reading text (Anderson, 1975), (2) the position of questions closer to the reading text facilitated increased performance on repeated criterion test items (Anderson, 1971; Sones, 1940), (3) the type of question employed, either short-answer/completion or multiple-choice questions had high effects on test results, (Anderson, 1971; Roderick, 1968; Williams, 1963), but long-answers and essay-answers had a greater effect on test results (Anderson, 1967; Holland, 1965; Kemp, 1966; Michael, 1961), (4) higher order thinking skill questions produced significantly higher results on the criterion test (Watts, 1071), (5) the feedback displaying the correct answer enhances performance on repeated criterion test items, regardless of the position of the adjunct questions (Frase, 1968b; Maccoby, 1961; Michael, 1961; Rothkopf, 1974; Throop, 1971), and (6) motivation (money) did affect test results (Frase, 1968a). The difference between questioned and non-questioned groups was a decreasing function of the amount of the money. Also, (7) length of the reading text, topic age of the subject, nor the medium of presentation (text, taped lecture, film) seem to affect test results. [Positive results from adjunct questions have been obtained over a range of each of the above (Anderson, 1975)].

Note worthy research by Rickards and Hatcher (1978) suggested that the insertion of high level adjunct questions significantly enhanced the performance of “poor comprehenders”, i.e., readers whose vocabulary level was average or above but whose comprehension subtest score in a reading achievement test was one year or more below average (Rickards, 1978).

Methodology

The Rasch Model was used to assess quality and reliability of the study guide. Then, the study guide was used to evaluate a special education student's ability to answer study guide questions when utilizing speech technology. Specifically, explored the efficacy of a student, classified as learning disabled, to use computer-based speech feedback with a U. S. history textbook and teacher constructed study guide.

Design

Holt (2003) was used as the U. S. history textbook. This study took place in one teacher's high school classroom. Students were provided access to four classroom computers – Pentium/150 MHz personal computers with CD drives, with one student using the teacher's computer. The computers were loaded with Windows 98. Also, each computer had a sound card, 20 MB hard drive space, 24 MB RAM, and the speech program Write Out Loud.

The students were taught to use the Write Out Loud software. All the students were taught to use the mouse and pull down menus. The Write Out Loud program allowed each student to highlight the amount of text to be read by the computer. Letters, words, sentences, or entire documents were read aloud while the student (using headphones) answered questions about the text. The students customized the text with such features as: (1) background color, (2) text color, and (3) font size. The teacher typed the history book chapter into the computer, duplicated the text color, bolded letters, set font size, and italicized words displayed in the textbook. Also, the study guide was typed and saved to each computer. The students were presented with text only, graphics were not used

The teacher set up the computers for use in the classroom and installed the Write Out Loud software. The Michigan Social Studies pacing chart was used to determine at what point each chapter was presented. Each student used a study guide and answered questions on the study guide. The questions for the study guide were developed based on the goals and objectives of the teacher's manual for Boyer and Stuckey's (2003) *American Nation in the Modern Era* and the student's IEP. The teacher will typed the study guide using the Write Out Loud software and made the files accessible for the students.

This study began with students who had varying degrees of academic and attempted to determine if assistive technology affected the student's ability to answer classroom questions. The study investigated the influence of assistive technology, on the students' ability to answer questions on a classroom study guide. The independent variable – assistive technology – was scheduled to allow five students access to the five computers in the classroom. The study was conducted while the students used assistive technology during the natural course of events in a classroom. The study was not randomized or variables manipulated, therefore the study was ex post facto research.

This study employed two evaluation designs. The Rasch portion of the study did not require a control group. Thus, the lack of randomization did not affect this portion of the study. The second concept was whether assistive technology effectively affected the ability to answer study guide questions by a disabled student in the basic classroom. A single-subject design was utilized**.** The student will be alternately exposed to the assistive technology. Because the classroom will have only four computers to service five students. The single-subject student was scheduled to use the teacher's computer. The sequence of single subject student measurements resulted in a A-B-A-B design as symbolized below:

OOO	XOXOXO	OOO	XOXOXO
Base line phase	Treatment phase	Baseline phase	Treatment phase

A	B	A	B

Extraneous variables or sources of error were identified

Extraneous variables were controlled with the single-subject design. This study addressed each of Campbell and Stanley's (1971) threats. First, the extraneous variable history was controlled by repeated measures of the student's academic ability at various points in time while the student used assistive technology. The single-subject design required sequential measures of pretest performance for the subject's (baseline measures), over a period of time, to control maturation. Secondly, testing-pretest sensitization should not have occurred because base line data versus pretest data was collected. Thirdly, instrumentation was controlled with measurement for the student, making sure each procedure was performed exactly the same way every time. Next, the single-subject design group measurement was not used, therefore, neither statistical regression nor differential selection of subjects affected the internal validity. Without group measurement, selection-maturation interaction did not affect the study. Finally, mortality was controlled by the high desire of the students to complete the required world history course to graduate.

Intervening variables could have affected the validity. Computer skill could have been a factor affecting the use of computer assistance. But the single student had computer experience, therefore, the lack of ability to use the computer was not an intervening variable.

The physical environment with the computers in close proximity to each other may have contributed itself to collaborative work. The act of using headphones may have hinder individual discussions to the point that student discussion of individual questions did not take place.

Therefore, the variables “ability” and “item difficulty” were not compromised by students discussing the best possible answers with each other.

The social environment in the classroom was the variable “classroom behavior management”. The teacher played a major role in establishing an environment conducive to learning. The extraneous variable “classroom behavior” could have directly affected “ability” if the student had not stayed on task because of the behavior of other students in the class.

The above variables were controlled, therefore, they will not hinder or interfere with the relationship between assistive technology and ability to answer questions.

When using simultaneous speech and reading, Higgins and Ziv stated that there is a hindrance factor with “high” readers (Higgins, 1995). Higgins and Ziv did not quantify “high”. The reading level was monitored in this study by: (1) determining student reading levels and (2) allowing students only below the third grade reading level to use assistive technology.

Ten minutes of class time was used to gain the students’ attention, talk about the objective of the reading and review the history time line of the lesson in relation to previous history. During the last five minutes of class the teacher will implemented a verbal assessment by asking each student “what they learned” and provided verbal feedback.

Varying levels of computer skills were addressed by providing computer instruction at the beginning of the semester. Most of the students had some computer skills. A majority of the students had a computer literacy class in middle school. All of the students in the history computerized speech class had a review of how to turn the computer on and off, assess the required program and files, and use the keyboard and mouse. The speech program will have a tool bar with icons to show the program processes much like a word processing program.

To help students use the computerized speech system, the teacher assisted the students during the first chapter to: (1) read/listen to the questions on the study guide, (2) go to the appropriate location in the text (based on headings and subheadings), (3) read/listen to the text, (4) locate the answer to the question, (5) write the answer on their paper, and (6) discuss what they learned.

The researcher took detailed notes recording the physical environment of the classroom in the now-closed high school. The classroom was approximately 20’ by 20’. It had wall-to-wall blackboards on two walls. The third wall had built in drawers, closets and counters. Three lab tables were positioned against the fourth wall, creating one long table. Four vertical central processing units, monitors, keyboards and headphones comprised four workstations along the fourth wall. The computers were placed in the optimal position for power and space. The students were seated approximately two feet apart.

Sample

Two samples were used. The first consisted of 15 students in a ninth-grade history class. In the second part of this study a single student participated. The classroom sample was drawn from one hundred ninth grade special education students in an urban high school. Each of the students had an Individualized Education Plan (IEP). The students had been placed at the school by the placement office at the central special education office. All of the students had been determined eligible for special education services. All of the students attended at least two general education classes and received special education support for four of their classes. The computerized speech History class was a “basic” American history class developed to meet the needs of students unable to succeed in the general education program. The students utilized the Michigan general education textbook, pacing schedule, and curriculum for the American History course.

The number of students scheduled into the computerized speech History did not exceed fifteen. A state of Michigan mandate was in effect that basic special education teachers could have no more than an average of thirteen students per day with a maximum of fifteen students in one class period. The fifteen students' categories were: (1) Learning Disabilities, (2) Cognitive Impairment or (3) Emotionally Impaired. The majority of the students were learning disabled. The number of students allowed to use the assistive technology computer was determined by the student's reading ability, and the availability of the four computers in the classroom.

Students were given the Brigance (1981) word recognition test during the first week of class, and if they scored below third grade reading level they were asked to use the computer to complete their work.

The single student was randomly selected among the students using the computers.

Sampling plan

A counselor assigned each student into the classroom. Students were assigned to counselors based on the student's last name. The counselors assigned ninth grade students to several U. S. history classes. Each ninth grade student had the same opportunity to take history. On the same day, each counselor worked on programming all the ninth grade schedules. The counselors used a computer program to assign students to the required history courses. The computer program informed the counselor when the class was full. The technology history was limited to fifteen students. Since the scheduling process was computerized, the chance to get the speech feedback class was dependent on how fast the student's counselor entered the student's name and what other classes impacted the student's schedule. The computerized speech history class was solely for special education students, therefore only disabled ninth grade students were scheduled into this class.

The first part of the sampling plan was not random. The sampling plan was not representative of how most urban high schools schedule students into classes. This sampling plan was appropriate for the item response modeling utilized in this study. In the second part of the study, one student was randomly selected from the students using assistive technology to determine if that student's ability to answer more questions was influenced by the use of assistive technology. Using the procedure outline by Glass to select random samples, one student was selected using the table of random numbers (Glass & Stanley, 1970). This sampling plan was appropriate for the single-subject design utilized in the second part of the study

Data

Word recognition and reading grade placement were assessed for each student using Brigance Diagnostic Inventory of Essential Skills (Brigance, 1981). The Brigance was administered to all students during the first day of class. Each student was presented the test sheet with a list of ten words from grade levels pre-primer to tenth. The teacher worked one-to-one with each student. The grade level was determined when the student missed five of the ten words at a certain grade level. The grade level for each student was recorded. The students that scored below a third grade reading placement were asked to use the assistive technology.

Holt's *American Nation in the Modern Era* (2003) was the required textbook for the general education population. This textbook was the required textbook for the special education population. A twelfth grade readability (as determined by Microsoft Flesh-Kincaid formula) was calculated using the-one hundred word passages at the beginning, middle and end of the text book. The textbook content aligned with the Michigan Benchmarks. The strands (objectives) of the benchmarks were captured using the suggested test questions incorporated into the textbook and teacher's manual.

The students were handed daily study guides at the start of class. The students took a book and study guide to the computer station. The remainder of the class turned to the appropriate chapter in the textbook, read, and completed the study guide. The students were required to answer twenty-five questions for approximately thirty-five minutes using the required history textbook and study guide. The teacher facilitated silent reading, computer assisted reading, and the answering of the questions with each student at their individual desks. The students at the computer had headphones. The students at the computers were able to access the questions at their computers. They were able to join any discussion that took place during the class period. The study guides were collected at the end of each class period. The teacher marked the questions on the study guide either correct or incorrect.

The data gathering methods mirrored the grading procedures for a student in a high school classroom. The goal of this study was to measure the special education students' ability to answer the type of questions they would encounter in a regular education classroom. The data gathering method followed that of a regular classroom. Therefore, the instructional and grading procedure used in this study was appropriate for this study.

Instruments

The study guide was the major assessment instrument used in this study. The study guide questions followed the content of each chapter of the textbook. The study guide was criteria referenced. The principle objective of this criterion-referenced assessment was to assess the specific amount of correctly answered questions that the student was able to complete during a class period. This criterion-referenced assessment was tied to instructional objectives, and individual items designed to assess mastery of specific objectives. (Salvia, 1991). The study guides were designed to assess knowledge of specific U. S. history objectives as outlined by the state of Michigan standards. The objectives or strands correlated to a pacing chart. The pacing chart was used to present each objective at an assigned sequence and time period through out the school year. The teacher used the textbook and the teacher's manual to develop the study guide questions.

The unique feature of the study guide was that the questions were formatted to show where the answer could be found in the textbook. Students read/listened to the text and answered related questions on the guide. The questions were sequentially numbered and sequentially followed the content of the textbook. The student never had to "go back" to search for an answer outside of the subheading.

The questions followed the developmental methods outlined by Smith and Regan (1993). For example, the questions were developed based on the type of learning associated with the objective. If an objective asked the student to learn verbal information, such as the meaning of a word, then the study guide question asked the student to write the definition of the word. To meet the requirements of students' Individualized Educational Plans (IEP), questions were included that asked who, what, when or where. Questions were developed for bolded words. Approximately, twenty-five short-answer or fill-in-the-blank questions were developed per chapter. The students were asked to answer the study guide questions with a hand written response. This assessment was important because the special education student needed to be able to pass criteria referenced assessments on a daily basis in order to pass the class.

Instrument reliability

One of the major questions of this study was whether the Rasch model measured the reliability and validity of the study guide questions. Specifically, did the Rasch model provide reliability and validity information that could be used by the classroom teacher to make more effective and efficient study guides? The study guide was an instrument that required the student to answer70% of the questions correctly to pass the history class.

The second assessment instrument used in this study was the Brigance Diagnostic Inventory of Essential Skills (1981). The *Brigance Diagnostic Inventory of Essential Skills* was used to determine Word Recognition Grade Placement. The Brigance for secondary students was field tested (Brigance, 1981). The purpose of the "Word Recognition Grade Placement" assessment was to provide a means of making a quick assessment of a student's word recognition skills. Students were given a one hundred word test with the words grouped into ten grade levels. The students were assigned a grade level when five words were missed at a specific grade level. The Brigance test was used to assess the word recognition grade placement for all the students in the U. S. history classes. The Brigance (1981) was the assessment of choice by the Special Education Department of the school district.

Data analysis

Scales of measurement detailed.

The study guide questions werescored dichotomously (right/wrong). This method of scoring the study guide will lended itself to Rasch's dichotomous model. Successfully mastering the study guide questions was interpreted as evidence of increased ability. Answering more questions wrong was interpreted as evidence of decreased ability.

With the Rasch dichotomous model, each item had a difficulty parameter. Items were constrained to be equally discriminating and with equal probability of correct guessing. The Rasch model contained one item parameter – "item difficulty". Specifically, item difficulty referred to that point on the ability scale where a correct item response will become more likely to occur than an incorrect response. This will allow for the location of each item on the ability scale. Some items will be easy (located at the low ability end of the scale) and other items will be more difficult (located at the high ability end of the scale). Given the student's ability, as an item became more difficult, the probability of a correct response diminished. From another perspective, given an item's difficulty, as the student's ability increased, the probability of a correct response increased. Estimating the probability of a specific response was based on a comparison of the student's ability and the item characteristic(s).

Statistical hypothesis

The study suggested that disabled students using computerized speech with study guides would be able to answer more difficult questions. Using a single subject design, this study did not generalize that disabled students using computerized speech could increase their achievement or classroom grade.

Statistical tests

This study had two major goals: (a) to explore the use of the Rasch Model to determine the quality and reliability of the study guide, and (b) to explore the use of the Rasch Model to determine if student ability will increase with the use of electronic speech and study strategies.

Specifically, the second half of the study was designed to determine if using computerized speech and a study guide in a special education basic classroom would increase student achievement. The student using computerized speech and study guides was graded daily to determine which questions were right or wrong. The study guide data allowed the teacher to determine whether the computer/study guide intervention could assist a special education student with the daily reading and the answering of study guide questions. This study tested the research hypothesis that a student using the computer/study guide increases ability to answer history study guide questions.

Using the Rasch model and t-test analysis the research questions were assessed. Decisions on the statistical significance of the findings were made using an alpha level of .05 and .01. Table 1 presents the data analyses that were used to address each of the research questions developed for the study.

Table 1

Statistical Analysis for Rasch Modeling with Computer Assistive Technology in a High School Special Education Classroom

Research questions	Variables	Statistical Analysis
When using the Rasch model can the study guide reliability and validity be determined?	Answers on the study guide when using Assistive technology and not using assistive technology	a. Rasch dichotomous model were used to set the item difficulty estimates, and the person ability scores were estimated in relation to the item mean. b. Two programs: Winsteps Version 3.68.2 and BILOG-MG V3.0 were used to analyze the data to determine reliability and validity.
When using the Rasch model determine if a special education student's ability to answer questions changes with the assistance of assistive technology.	Answers on the study guide when using Assistive technology and not using assistive technology	c. The t-test was used to examine if an individual student scores significantly improve when using assistive technology

Results

This study evaluated seventeen study guides used by fifteen students in a U. S. history class. Five students used assistive technology. Students read or listened to Holt's American Nation in the Modern Era's chapters 1, 2, 3, 4, 5, 7, 12, 14, 15, and 17 and then answered study guide questions which were combined to form four hundred fifteen items.

Table 1 presents the computer printout using the statistical Package BLOG one parameter logistic response model. The table delineates the percent, logit, Pearson, and biserial for each item.

Table 2

Item statistics for U.S. History Study Guides

ITEM	NAME	#TRIED	#RIGHT	PCT	LOGIT	PEARSON	BISERIAL
1	ITEM0001	5.0	5.0	100.0	-99.99	0.000	0.000
2	ITEM0002	5.0	5.0	100.0	-99.99	0.000	0.000
3	ITEM0003	5.0	5.0	100.0	-99.99	0.000	0.000
4	ITEM0004	5.0	5.0	100.0	-99.99	0.000	0.000
5	ITEM0005	5.0	5.0	100.0	-99.99	0.000	0.000
6	ITEM0006	5.0	5.0	100.0	-99.99	0.000	0.000
7	ITEM0007	5.0	5.0	100.0	-99.99	0.000	0.000
8	ITEM0008	5.0	4.0	80.0	-1.39	-0.630	-0.901
9	ITEM0009	5.0	5.0	100.0	-99.99	0.000	0.000
10	ITEM0010	5.0	4.0	80.0	-1.39	0.099	0.141
11	ITEM0011	5.0	4.0	80.0	-1.39	0.563	0.805
12	ITEM0012	5.0	5.0	100.0	-99.99	0.000	0.000
13	ITEM0013	5.0	5.0	100.0	-99.99	0.000	0.000
14	ITEM0014	5.0	4.0	80.0	-1.39	-0.630	-0.901
15	ITEM0015	5.0	4.0	80.0	-1.39	-0.630	-0.901
16	ITEM0016	5.0	3.0	60.0	-0.41	-0.952	-1.207
17	ITEM0017	5.0	4.0	80.0	-1.39	-0.630	-0.901
18	ITEM0018	5.0	3.0	60.0	-0.41	-0.952	-1.207
19	ITEM0019	5.0	4.0	80.0	-1.39	-0.630	-0.901
20	ITEM0020	5.0	4.0	80.0	-1.39	-0.630	-0.901
21	ITEM0021	5.0	3.0	60.0	-0.41	-0.426	-0.541
22	ITEM0022	6.0	5.0	83.3	-1.61	0.799	1.192
23	ITEM0023	6.0	5.0	83.3	-1.61	0.799	1.192

24	ITEM0024	6.0	5.0	83.3	-1.61	0.799	1.192
25	ITEM0025	6.0	4.0	66.7	-0.69	0.778	1.009
26	ITEM0026	6.0	4.0	66.7	-0.69	0.778	1.009
27	ITEM0027	6.0	4.0	66.7	-0.69	0.778	1.009
28	ITEM0028	6.0	4.0	66.7	-0.69	0.778	1.009
29	ITEM0029	6.0	3.0	50.0	0.00	0.799	1.002
30	ITEM0030	6.0	3.0	50.0	0.00	0.799	1.002
31	ITEM0031	6.0	3.0	50.0	0.00	0.799	1.002
32	ITEM0032	6.0	3.0	50.0	0.00	0.799	1.002
33	ITEM0033	6.0	2.0	33.3	0.69	0.391	0.508
34	ITEM0034	6.0	1.0	16.7	1.61	0.432	0.644
35	ITEM0035	6.0	2.0	33.3	0.69	0.787	1.021
36	ITEM0036	6.0	2.0	33.3	0.69	0.787	1.021
37	ITEM0037	6.0	2.0	33.3	0.69	0.787	1.021
38	ITEM0038	6.0	2.0	33.3	0.69	0.787	1.021
39	ITEM0039	6.0	2.0	33.3	0.69	0.787	1.021

42	ITEM0042	6.0	2.0	33.3	0.69	0.787	1.021
43	ITEM0043	6.0	2.0	33.3	0.69	0.787	1.021
44	ITEM0044	6.0	1.0	16.7	1.61	0.432	0.644
45	ITEM0045	6.0	1.0	16.7	1.61	0.432	0.644
46	ITEM0046	5.0	5.0	100.0	-99.99	0.000	0.000
47	ITEM0047	5.0	5.0	100.0	-99.99	0.000	0.000
48	ITEM0048	5.0	5.0	100.0	-99.99	0.000	0.000
49	ITEM0049	5.0	5.0	100.0	-99.99	0.000	0.000
52	ITEM0052	5.0	5.0	100.0	-99.99	0.000	0.000
53	ITEM0053	5.0	4.0	80.0	-1.39	0.029	0.041
54	ITEM0054	5.0	3.0	60.0	-0.41	0.635	0.806
55	ITEM0055	5.0	5.0	100.0	-99.99	0.000	0.000
56	ITEM0056	5.0	4.0	80.0	-1.39	0.741	1.058
57	ITEM0057	5.0	2.0	40.0	0.41	-0.308	-0.390
58	ITEM0058	5.0	4.0	80.0	-1.39	0.741	1.058
59	ITEM0059	5.0	3.0	60.0	-0.41	0.635	0.806
60	ITEM0060	5.0	3.0	60.0	-0.41	0.853	1.082
61	ITEM0061	5.0	3.0	60.0	-0.41	0.853	1.082
62	ITEM0062	5.0	4.0	80.0	-1.39	0.741	1.058
63	ITEM0063	5.0	3.0	60.0	-0.41	0.168	0.213
64	ITEM0064	5.0	3.0	60.0	-0.41	0.098	0.124
65	ITEM0065	5.0	4.0	80.0	-1.39	0.741	1.058
66	ITEM0066	5.0	2.0	40.0	0.41	0.350	0.444
67	ITEM0067	5.0	3.0	60.0	-0.41	0.853	1.082

68	ITEM0068	5.0	3.0	60.0	-0.41	0.853	1.082
69	ITEM0069	9.0	8.0	88.9	-2.08	-0.410	-0.681
70	ITEM0070	9.0	9.0	100.0	-99.99	0.000	0.000
71	ITEM0071	9.0	9.0	100.0	-99.99	0.000	0.000
72	ITEM0072	9.0	9.0	100.0	-99.99	0.000	0.000
73	ITEM0073	9.0	8.0	88.9	-2.08	-0.410	-0.681
74	ITEM0074	9.0	9.0	100.0	-99.99	0.000	0.000
75	ITEM0075	9.0	6.0	66.7	-0.69	0.408	0.530
76	ITEM0076	9.0	6.0	66.7	-0.69	0.612	0.793
77	ITEM0077	9.0	6.0	66.7	-0.69	0.750	0.973
78	ITEM0078	9.0	5.0	55.6	-0.22	0.813	1.022
79	ITEM0079	9.0	3.0	33.3	0.69	0.367	0.476
80	ITEM0080	9.0	5.0	55.6	-0.22	0.643	0.809
81	ITEM0081	9.0	4.0	44.4	0.22	0.652	0.820
82	ITEM0082	9.0	3.0	33.3	0.69	0.367	0.476
83	ITEM0083	9.0	3.0	33.3	0.69	0.419	0.543
86	ITEM0086	9.0	3.0	33.3	0.69	0.443	0.575
87	ITEM0087	10.0	5.0	50.0	0.00	0.137	0.171
88	ITEM0088	10.0	4.0	40.0	0.41	-0.378	-0.480
89	ITEM0089	10.0	7.0	70.0	-0.85	0.689	0.909
90	ITEM0090	10.0	5.0	50.0	0.00	0.598	0.750
91	ITEM0091	10.0	7.0	70.0	-0.85	0.429	0.566
94	ITEM0094	10.0	8.0	80.0	-1.39	0.640	0.915
95	ITEM0095	10.0	7.0	70.0	-0.85	0.689	0.909
96	ITEM0096	10.0	5.0	50.0	0.00	0.112	0.140
97	ITEM0097	10.0	7.0	70.0	-0.85	0.212	0.280
98	ITEM0098	10.0	6.0	60.0	-0.41	0.538	0.682
99	ITEM0099	10.0	8.0	80.0	-1.39	0.640	0.915
100	ITEM0100	10.0	7.0	70.0	-0.85	0.429	0.566
101	ITEM0101	10.0	8.0	80.0	-1.39	0.640	0.915
102	ITEM0102	10.0	6.0	60.0	-0.41	0.564	0.715
103	ITEM0103	10.0	3.0	30.0	0.85	0.087	0.114
104	ITEM0104	10.0	7.0	70.0	-0.85	0.619	0.816
105	ITEM0105	10.0	7.0	70.0	-0.85	0.619	0.816
106	ITEM0106	10.0	4.0	40.0	0.41	0.198	0.251
107	ITEM0107	10.0	6.0	60.0	-0.41	0.529	0.671
108	ITEM0108	10.0	4.0	40.0	0.41	0.295	0.375
109	ITEM0109	10.0	5.0	50.0	0.00	0.401	0.503
110	ITEM0110	10.0	6.0	60.0	-0.41	0.529	0.671
111	ITEM0111	10.0	4.0	40.0	0.41	0.295	0.375
112	ITEM0112	10.0	4.0	40.0	0.41	0.537	0.681

113	ITEM0113	10.0	5.0	50.0	0.00	0.479	0.601
114	ITEM0114	10.0	6.0	60.0	-0.41	0.529	0.671
115	ITEM0115	10.0	5.0	50.0	0.00	0.206	0.258
116	ITEM0116	9.0	7.0	77.8	-1.25	-0.054	-0.076
117	ITEM0117	9.0	8.0	88.9	-2.08	0.100	0.165
118	ITEM0118	9.0	7.0	77.8	-1.25	-0.043	-0.060
119	ITEM0119	9.0	9.0	100.0	-99.99	0.000	0.000
120	ITEM0120	9.0	8.0	88.9	-2.08	0.100	0.165
121	ITEM0121	9.0	9.0	100.0	-99.99	0.000	0.000
122	ITEM0122	9.0	8.0	88.9	-2.08	0.037	0.062
123	ITEM0123	9.0	6.0	66.7	-0.69	0.484	0.627
124	ITEM0124	9.0	6.0	66.7	-0.69	0.395	0.512
125	ITEM0125	9.0	8.0	88.9	-2.08	0.037	0.062
126	ITEM0126	9.0	7.0	77.8	-1.25	0.077	0.107
127	ITEM0127	9.0	7.0	77.8	-1.25	0.667	0.931

130	ITEM0130	9.0	6.0	66.7	-0.69	0.081	0.105
131	ITEM0131	9.0	5.0	55.6	-0.22	0.027	0.034
132	ITEM0132	9.0	7.0	77.8	-1.25	-0.043	-0.060
133	ITEM0133	9.0	7.0	77.8	-1.25	0.107	0.149
136	ITEM0136	7.0	6.0	85.7	-1.79	-0.304	-0.471
137	ITEM0137	7.0	7.0	100.0	-99.99	0.000	0.000
138	ITEM0138	7.0	6.0	85.7	-1.79	0.035	0.054
139	ITEM0139	7.0	6.0	85.7	-1.79	-0.006	-0.009
140	ITEM0140	7.0	6.0	85.7	-1.79	-0.594	-0.922
141	ITEM0141	7.0	6.0	85.7	-1.79	0.797	1.236
142	ITEM0142	7.0	3.0	42.9	0.29	0.384	0.484
143	ITEM0143	7.0	5.0	71.4	-0.92	0.025	0.033
144	ITEM0144	7.0	5.0	71.4	-0.92	-0.206	-0.274
145	ITEM0145	7.0	4.0	57.1	-0.29	0.736	0.928
146	ITEM0146	7.0	4.0	57.1	-0.29	0.736	0.928
147	ITEM0147	7.0	4.0	57.1	-0.29	0.736	0.928
148	ITEM0148	7.0	3.0	42.9	0.29	0.745	0.940
149	ITEM0149	7.0	3.0	42.9	0.29	0.526	0.663
150	ITEM0150	7.0	2.0	28.6	0.92	0.353	0.469
151	ITEM0151	7.0	2.0	28.6	0.92	0.588	0.781
152	ITEM0152	7.0	2.0	28.6	0.92	0.588	0.781
153	ITEM0153	7.0	1.0	14.3	1.79	0.165	0.256
154	ITEM0154	7.0	2.0	28.6	0.92	0.588	0.781
155	ITEM0155	7.0	0.0	0.0	99.99	0.000	0.000
156	ITEM0156	7.0	1.0	14.3	1.79	0.590	0.915

157	ITEM0157	7.0	0.0	0.0	99.99	0.000	0.000
158	ITEM0158	8.0	1.0	12.5	1.95	-0.123	-0.198
159	ITEM0159	8.0	2.0	25.0	1.10	0.362	0.493
160	ITEM0160	8.0	3.0	37.5	0.51	0.294	0.375
161	ITEM0161	8.0	2.0	25.0	1.10	-0.130	-0.177
162	ITEM0162	8.0	1.0	12.5	1.95	0.595	0.956
163	ITEM0163	8.0	1.0	12.5	1.95	0.177	0.284
164	ITEM0164	8.0	1.0	12.5	1.95	0.177	0.284
165	ITEM0165	8.0	1.0	12.5	1.95	0.595	0.956
166	ITEM0166	8.0	2.0	25.0	1.10	0.592	0.807
167	ITEM0167	8.0	1.0	12.5	1.95	0.595	0.956
168	ITEM0168	7.0	6.0	85.7	-1.79	0.090	0.139
169	ITEM0169	7.0	5.0	71.4	-0.92	0.128	0.170
170	ITEM0170	7.0	6.0	85.7	-1.79	-0.164	-0.254
171	ITEM0171	7.0	6.0	85.7	-1.79	-0.164	-0.254

174	ITEM0174	7.0	6.0	85.7	-1.79	0.119	0.185
175	ITEM0175	7.0	3.0	42.9	0.29	0.323	0.407
178	ITEM0178	7.0	5.0	71.4	-0.92	0.483	0.642
179	ITEM0179	7.0	6.0	85.7	-1.79	0.786	1.219
180	ITEM0180	7.0	4.0	57.1	-0.29	0.532	0.671
181	ITEM0181	7.0	5.0	71.4	-0.92	0.646	0.858
182	ITEM0182	7.0	5.0	71.4	-0.92	0.646	0.858
183	ITEM0183	7.0	5.0	71.4	-0.92	0.646	0.858
184	ITEM0184	7.0	4.0	57.1	-0.29	0.137	0.172
185	ITEM0185	7.0	4.0	57.1	-0.29	0.476	0.600
186	ITEM0186	7.0	4.0	57.1	-0.29	0.661	0.834
187	ITEM0187	7.0	3.0	42.9	0.29	0.757	0.955
188	ITEM0188	7.0	3.0	42.9	0.29	0.550	0.694
189	ITEM0189	7.0	4.0	57.1	-0.29	0.661	0.834
190	ITEM0190	7.0	3.0	42.9	0.29	0.757	0.955
191	ITEM0191	7.0	2.0	28.6	0.92	0.711	0.944
192	ITEM0192	7.0	3.0	42.9	0.29	0.550	0.694
193	ITEM0193	7.0	2.0	28.6	0.92	0.112	0.149
194	ITEM0194	7.0	3.0	42.9	0.29	0.210	0.265
195	ITEM0195	7.0	2.0	28.6	0.92	0.337	0.447
196	ITEM0196	7.0	3.0	42.9	0.29	0.210	0.265
197	ITEM0197	7.0	3.0	42.9	0.29	0.210	0.265
198	ITEM0198	7.0	2.0	28.6	0.92	0.337	0.447
199	ITEM0199	7.0	2.0	28.6	0.92	0.112	0.149
200	ITEM0200	7.0	1.0	14.3	1.79	0.285	0.442

201	ITEM0201	5.0	4.0	80.0	-1.39	0.033	0.048
202	ITEM0202	5.0	4.0	80.0	-1.39	0.033	0.048
203	ITEM0203	5.0	4.0	80.0	-1.39	0.033	0.048
204	ITEM0204	5.0	3.0	60.0	-0.41	0.183	0.232
205	ITEM0205	5.0	3.0	60.0	-0.41	0.183	0.232
206	ITEM0206	5.0	4.0	80.0	-1.39	0.033	0.048
207	ITEM0207	5.0	5.0	100.0	-99.99	0.000	0.000
208	ITEM0208	5.0	4.0	80.0	-1.39	-0.832	-1.189
209	ITEM0209	5.0	4.0	80.0	-1.39	-0.832	-1.189
210	ITEM0210	5.0	4.0	80.0	-1.39	0.460	0.657
211	ITEM0211	5.0	5.0	100.0	-99.99	0.000	0.000
212	ITEM0212	5.0	5.0	100.0	-99.99	0.000	0.000
213	ITEM0213	5.0	2.0	40.0	0.41	0.225	0.285
214	ITEM0214	4.0	3.0	75.0	-1.10	0.182	0.248
215	ITEM0215	4.0	4.0	100.0	-99.99	0.000	0.000

220	ITEM0220	2.0	2.0	100.0	-99.99	0.000	0.000
221	ITEM0221	2.0	2.0	100.0	-99.99	0.000	0.000
222	ITEM0222	2.0	1.0	50.0	0.00	-1.000	-1.253
223	ITEM0223	2.0	1.0	50.0	0.00	1.000	1.253
224	ITEM0224	2.0	1.0	50.0	0.00	-1.000	-1.253
225	ITEM0225	2.0	2.0	100.0	-99.99	0.000	0.000
226	ITEM0226	2.0	1.0	50.0	0.00	-1.000	-1.253
227	ITEM0227	2.0	1.0	50.0	0.00	-1.000	-1.253
228	ITEM0228	2.0	1.0	50.0	0.00	-1.000	-1.253
229	ITEM0229	2.0	2.0	100.0	-99.99	0.000	0.000
230	ITEM0230	2.0	1.0	50.0	0.00	1.000	1.253
231	ITEM0231	2.0	1.0	50.0	0.00	1.000	1.253
232	ITEM0232	2.0	1.0	50.0	0.00	1.000	1.253
233	ITEM0233	2.0	0.0	0.0	99.99	0.000	0.000
234	ITEM0234	2.0	1.0	50.0	0.00	1.000	1.253
235	ITEM0235	2.0	0.0	0.0	99.99	0.000	0.000
236	ITEM0236	2.0	0.0	0.0	99.99	0.000	0.000
237	ITEM0237	2.0	1.0	50.0	0.00	1.000	1.253
238	ITEM0238	1.0	0.0	0.0	99.99	0.000	0.000
239	ITEM0239	1.0	0.0	0.0	99.99	0.000	0.000
240	ITEM0240	1.0	0.0	0.0	99.99	0.000	0.000
241	ITEM0241	1.0	0.0	0.0	99.99	0.000	0.000
242	ITEM0242	1.0	0.0	0.0	99.99	0.000	0.000
243	ITEM0243	4.0	3.0	75.0	-1.10	0.944	1.286
244	ITEM0244	4.0	3.0	75.0	-1.10	-0.099	-0.135

245	ITEM0245	4.0	2.0	50.0	0.00	-0.297	-0.372
246	ITEM0246	4.0	2.0	50.0	0.00	-0.297	-0.372
247	ITEM0247	4.0	3.0	75.0	-1.10	-0.249	-0.339
248	ITEM0248	4.0	3.0	75.0	-1.10	-0.249	-0.339
249	ITEM0249	4.0	4.0	100.0	-99.99	0.000	0.000
250	ITEM0250	4.0	3.0	75.0	-1.10	-0.249	-0.339
251	ITEM0251	4.0	4.0	100.0	-99.99	0.000	0.000
252	ITEM0252	4.0	4.0	100.0	-99.99	0.000	0.000
253	ITEM0253	4.0	4.0	100.0	-99.99	0.000	0.000
254	ITEM0254	4.0	4.0	100.0	-99.99	0.000	0.000
255	ITEM0255	4.0	4.0	100.0	-99.99	0.000	0.000
256	ITEM0256	4.0	2.0	50.0	0.00	0.603	0.756
257	ITEM0257	4.0	1.0	25.0	1.10	0.608	0.828
258	ITEM0258	4.0	2.0	50.0	0.00	0.603	0.756
259	ITEM0259	4.0	2.0	50.0	0.00	0.603	0.756

262	ITEM0262	4.0	2.0	50.0	0.00	0.603	0.756
263	ITEM0263	4.0	2.0	50.0	0.00	0.603	0.756
264	ITEM0264	4.0	2.0	50.0	0.00	0.603	0.756
265	ITEM0265	4.0	0.0	0.0	99.99	0.000	0.000
266	ITEM0266	4.0	1.0	25.0	1.10	0.608	0.828
267	ITEM0267	7.0	5.0	71.4	-0.92	-0.184	-0.245
268	ITEM0268	7.0	7.0	100.0	-99.99	0.000	0.000
269	ITEM0269	7.0	6.0	85.7	-1.79	-0.601	-0.932
270	ITEM0270	7.0	7.0	100.0	-99.99	0.000	0.000
271	ITEM0271	7.0	5.0	71.4	-0.92	0.182	0.242
272	ITEM0272	7.0	7.0	100.0	-99.99	0.000	0.000
273	ITEM0273	7.0	6.0	85.7	-1.79	-0.266	-0.412
274	ITEM0274	7.0	7.0	100.0	-99.99	0.000	0.000
275	ITEM0275	7.0	5.0	71.4	-0.92	0.538	0.715
276	ITEM0276	7.0	5.0	71.4	-0.92	-0.184	-0.245
277	ITEM0277	7.0	5.0	71.4	-0.92	0.552	0.733
278	ITEM0278	7.0	5.0	71.4	-0.92	-0.184	-0.245
279	ITEM0279	7.0	4.0	57.1	-0.29	-0.352	-0.444
280	ITEM0280	7.0	6.0	85.7	-1.79	-0.112	-0.174
281	ITEM0281	7.0	6.0	85.7	-1.79	-0.112	-0.174
282	ITEM0282	7.0	6.0	85.7	-1.79	-0.112	-0.174
283	ITEM0283	7.0	6.0	85.7	-1.79	-0.112	-0.174
284	ITEM0284	7.0	6.0	85.7	-1.79	-0.112	-0.174
285	ITEM0285	7.0	4.0	57.1	-0.29	0.564	0.711
286	ITEM0286	7.0	4.0	57.1	-0.29	0.564	0.711

287	ITEM0287	7.0	3.0	42.9	0.29	0.478	0.602
288	ITEM0288	7.0	3.0	42.9	0.29	0.478	0.602
289	ITEM0289	7.0	3.0	42.9	0.29	0.478	0.602
290	ITEM0290	7.0	3.0	42.9	0.29	0.478	0.602
291	ITEM0291	7.0	0.0	0.0	99.99	0.000	0.000
292	ITEM0292	7.0	0.0	0.0	99.99	0.000	0.000
293	ITEM0293	6.0	6.0	100.0	-99.99	0.000	0.000
294	ITEM0294	6.0	4.0	66.7	-0.69	-0.273	-0.354
295	ITEM0295	6.0	6.0	100.0	-99.99	0.000	0.000
296	ITEM0296	6.0	6.0	100.0	-99.99	0.000	0.000
297	ITEM0297	6.0	6.0	100.0	-99.99	0.000	0.000
298	ITEM0298	6.0	6.0	100.0	-99.99	0.000	0.000
299	ITEM0299	6.0	4.0	66.7	-0.69	0.627	0.812
300	ITEM0300	6.0	6.0	100.0	-99.99	0.000	0.000
301	ITEM0301	6.0	6.0	100.0	-99.99	0.000	0.000
--							
304	ITEM0304	6.0	0.0	0.0	99.99	0.000	0.000
305	ITEM0305	6.0	6.0	100.0	-99.99	0.000	0.000
306	ITEM0306	6.0	5.0	83.3	-1.61	0.876	1.306
307	ITEM0307	6.0	4.0	66.7	-0.69	0.784	1.016
308	ITEM0308	6.0	3.0	50.0	0.00	0.665	0.834
309	ITEM0309	6.0	1.0	16.7	1.61	0.230	0.343
310	ITEM0310	6.0	1.0	16.7	1.61	0.230	0.343
311	ITEM0311	6.0	2.0	33.3	0.69	0.239	0.310
312	ITEM0312	6.0	2.0	33.3	0.69	0.239	0.310
313	ITEM0313	6.0	1.0	16.7	1.61	0.068	0.102
314	ITEM0314	6.0	4.0	66.7	-0.69	-0.064	-0.083
315	ITEM0315	6.0	4.0	66.7	-0.69	-0.064	-0.083
316	ITEM0316	6.0	4.0	66.7	-0.69	-0.064	-0.083
317	ITEM0317	6.0	3.0	50.0	0.00	-0.500	-0.627
318	ITEM0318	6.0	5.0	83.3	-1.61	0.172	0.256
319	ITEM0319	6.0	3.0	50.0	0.00	-0.383	-0.480
320	ITEM0320	6.0	4.0	66.7	-0.69	-0.335	-0.434
321	ITEM0321	6.0	4.0	66.7	-0.69	-0.335	-0.434
322	ITEM0322	6.0	6.0	100.0	-99.99	0.000	0.000
323	ITEM0323	6.0	5.0	83.3	-1.61	0.852	1.271
324	ITEM0324	6.0	5.0	83.3	-1.61	0.852	1.271
325	ITEM0325	6.0	2.0	33.3	0.69	-0.072	-0.094
326	ITEM0326	6.0	3.0	50.0	0.00	-0.002	-0.003
327	ITEM0327	6.0	5.0	83.3	-1.61	0.852	1.271
328	ITEM0328	6.0	4.0	66.7	-0.69	0.196	0.254

329	ITEM0329	6.0	4.0	66.7	-0.69	0.196	0.254
330	ITEM0330	6.0	5.0	83.3	-1.61	0.852	1.271
331	ITEM0331	6.0	5.0	83.3	-1.61	0.852	1.271
332	ITEM0332	6.0	4.0	66.7	-0.69	0.817	1.060
333	ITEM0333	6.0	4.0	66.7	-0.69	0.817	1.060
334	ITEM0334	6.0	1.0	16.7	1.61	0.081	0.120
ITEM	NAME	#TRIED	#RIGHT	PCT	LOGIT	PEARSON	BISERIAL
335	ITEM0335	6.0	0.0	0.0	99.99	0.000	0.000
336	ITEM0336	6.0	0.0	0.0	99.99	0.000	0.000
337	ITEM0337	6.0	0.0	0.0	99.99	0.000	0.000
338	ITEM0338	6.0	0.0	0.0	99.99	0.000	0.000
339	ITEM0339	4.0	4.0	100.0	-99.99	0.000	0.000
340	ITEM0340	4.0	4.0	100.0	-99.99	0.000	0.000
341	ITEM0341	4.0	4.0	100.0	-99.99	0.000	0.000
342	ITEM0342	4.0	4.0	100.0	-99.99	0.000	0.000
343	ITEM0343	4.0	4.0	100.0	-99.99	0.000	0.000

346	ITEM0346	4.0	4.0	100.0	-99.99	0.000	0.000
347	ITEM0347	4.0	3.0	75.0	-1.10	-0.136	-0.185
348	ITEM0348	4.0	3.0	75.0	-1.10	-0.054	-0.073
349	ITEM0349	4.0	4.0	100.0	-99.99	0.000	0.000
350	ITEM0350	4.0	4.0	100.0	-99.99	0.000	0.000
351	ITEM0351	4.0	4.0	100.0	-99.99	0.000	0.000
352	ITEM0352	4.0	3.0	75.0	-1.10	-0.136	-0.185
353	ITEM0353	4.0	4.0	100.0	-99.99	0.000	0.000
354	ITEM0354	4.0	4.0	100.0	-99.99	0.000	0.000
355	ITEM0355	4.0	3.0	75.0	-1.10	-0.136	-0.185
356	ITEM0356	4.0	3.0	75.0	-1.10	-0.136	-0.185
357	ITEM0357	4.0	2.0	50.0	0.00	-0.144	-0.180
358	ITEM0358	4.0	2.0	50.0	0.00	-0.144	-0.180
359	ITEM0359	4.0	3.0	75.0	-1.10	-0.054	-0.073
360	ITEM0360	4.0	3.0	75.0	-1.10	-0.054	-0.073
361	ITEM0361	4.0	1.0	25.0	1.10	0.735	1.001
362	ITEM0362	4.0	1.0	25.0	1.10	-0.881	-1.200
363	ITEM0363	4.0	2.0	50.0	0.00	-0.687	-0.861
364	ITEM0364	4.0	2.0	50.0	0.00	-0.687	-0.861
365	ITEM0365	4.0	2.0	50.0	0.00	-0.687	-0.861
366	ITEM0366	4.0	2.0	50.0	0.00	-0.687	-0.861
367	ITEM0367	4.0	2.0	50.0	0.00	-0.687	-0.861
368	ITEM0368	4.0	2.0	50.0	0.00	-0.687	-0.861
369	ITEM0369	4.0	2.0	50.0	0.00	-0.687	-0.861
370	ITEM0370	5.0	2.0	40.0	0.41	-0.694	-0.881

371	ITEM0371	5.0	4.0	80.0	-1.39	-0.148	-0.211
372	ITEM0372	5.0	5.0	100.0	-99.99	0.000	0.000
373	ITEM0373	5.0	4.0	80.0	-1.39	-0.148	-0.211
374	ITEM0374	5.0	5.0	100.0	-99.99	0.000	0.000
375	ITEM0375	5.0	4.0	80.0	-1.39	-0.879	-1.256
376	ITEM0376	5.0	4.0	80.0	-1.39	-0.879	-1.256
377	ITEM0377	5.0	5.0	100.0	-99.99	0.000	0.000
378	ITEM0378	5.0	5.0	100.0	-99.99	0.000	0.000
379	ITEM0379	5.0	5.0	100.0	-99.99	0.000	0.000
380	ITEM0380	5.0	5.0	100.0	-99.99	0.000	0.000
381	ITEM0381	5.0	4.0	80.0	-1.39	0.154	0.220
382	ITEM0382	5.0	5.0	100.0	-99.99	0.000	0.000
383	ITEM0383	5.0	5.0	100.0	-99.99	0.000	0.000
384	ITEM0384	5.0	5.0	100.0	-99.99	0.000	0.000
385	ITEM0385	5.0	5.0	100.0	-99.99	0.000	0.000

388	ITEM0388	5.0	3.0	60.0	-0.41	0.672	0.852
389	ITEM0389	5.0	2.0	40.0	0.41	0.562	0.713
390	ITEM0390	5.0	2.0	40.0	0.41	0.562	0.713
391	ITEM0391	5.0	3.0	60.0	-0.41	0.672	0.852
392	ITEM0392	5.0	2.0	40.0	0.41	-0.052	-0.065
393	ITEM0393	5.0	1.0	20.0	1.39	0.872	1.246
394	ITEM0394	5.0	1.0	20.0	1.39	0.872	1.246
395	ITEM0395	5.0	0.0	0.0	99.99	0.000	0.000
396	ITEM0396	5.0	1.0	20.0	1.39	0.116	0.166
397	ITEM0397	5.0	1.0	20.0	1.39	0.116	0.166
398	ITEM0398	5.0	1.0	20.0	1.39	0.116	0.166
399	ITEM0399	4.0	4.0	100.0	-99.99	0.000	0.000
400	ITEM0400	4.0	4.0	100.0	-99.99	0.000	0.000
401	ITEM0401	4.0	4.0	100.0	-99.99	0.000	0.000
402	ITEM0402	4.0	3.0	75.0	-1.10	0.176	0.240
403	ITEM0403	4.0	3.0	75.0	-1.10	-0.122	-0.167
404	ITEM0404	4.0	2.0	50.0	0.00	0.054	0.068
405	ITEM0405	4.0	4.0	100.0	-99.99	0.000	0.000
406	ITEM0406	4.0	4.0	100.0	-99.99	0.000	0.000
407	ITEM0407	4.0	4.0	100.0	-99.99	0.000	0.000
408	ITEM0408	4.0	3.0	75.0	-1.10	-0.122	-0.167
409	ITEM0409	4.0	4.0	100.0	-99.99	0.000	0.000
410	ITEM0410	4.0	3.0	75.0	-1.10	0.176	0.240
411	ITEM0411	4.0	3.0	75.0	-1.10	0.176	0.240

412	ITEM0412	4.0	2.0	50.0	0.00	0.818	1.025
413	ITEM0413	4.0	2.0	50.0	0.00	0.818	1.025
414	ITEM0414	4.0	0.0	0.0	99.99	0.000	0.000
415	ITEM0415	4.0	1.0	25.0	1.10	0.090	0.122

Table 3 presents the misfit items. The statistical Package WINSTEP was used. The Entry Number represents the study guide items.

Table 3

Misfit Order for The Study Guide Items

ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
140	6	7	-1.65	1..13	1.50	.8	5.22	2.3
119	9	10	-1.99	1.09	1.33	.6	4.42	2.0
69	9	10	-1.87	1.13	1.48	.8	3.92	1.7
73	9	10	-1.87	1.13	1.48	.8	3.92	1.7
269	6	8	-1.21	.90	1.29	.7	3.24	2.1
375	4	5	-.70	1.14	1.10	.8	2.98	1.8
376	4	5	-.70	1.14	1.41	.8	2.98	1.8
273	7	8	-2.20	1.03	1045	.8	2.78	1.4
172	6	8	-.80	.89	1.82	1.6	2.71	1.9
340	4	5	-.72	1.14	1.38	.7	2.64	1.7
342	4	5	-.72	1.14	1.38	.7	2.64	1.7
343	4	5	-.72	1.14	1.38	.7	2.64	1.7
88	4	11	1.23	.68	1.76	2.3	2.52	2.7
245	2	4	.53	1.15	1.83	1.6	2.44	1.7
246	2	4	.53	1.15	1.83	1.6	2.44	1.7
220	2	3	.02	1.28	1.77	1.6	2.42	1.7
320	5	7	-.56	.93	1.66	1.3	2.41	1.7
321	5	7	-.56	.93	1.66	1.3	2.41	1.7

168	6	8	-.80	.89	1.67	1.3	2.40	1.7
208	4	6	-.52	.95	1.19	.6	2.27	1.7
209	4	6	-.52	.95	1.19	.6	2.27	1.7
328	4	6	-.48	.96	1.19	.6	2.18	1.6
329	4	6	-.48	.96	1.19	.6	2.18	1.6
ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	OUTFIT ZSTD	ENTRY NUMBER	TOTAL SCORE
317	4	7	.22	.85	1.78	2.0	2.15	2.0
392	2	3	.34	1.27	1.65	1.4	2.08	1.6
	Better	Fitting	Omitted	-----------	---------			
56	5	7	-.40	.95	.53	-1.0	.40	-.9
58	5	7	-.40	.95	.53	-1.0	.40	-.9
65	5	7	-.40	.95	.53	-1.0	.40	-.9
215	4	5	-1.38	1.22	.50	-.7	.33	-.3
218	4	5	-1.38	1.22	.50	-.7	.33	-.3
323	6	7	-1.63	1.17	.50	-.6	326	-.4
324	6	7	-1.63	1.17	.50	-.6	26	-.4
327	5	6	-1.58	1.18	.50	-.6	.30	-.4
330	5	6	-1.58	1.18	.50	-.6	.30	-.4
331	5	6	-1.58	1.18	.50	-.6	.30	-.4
47	6	7	-1.49	1.18	.50	-.6	.25	-.3
49	6	7	-1.49	1.18	.50	-.6	.25	-.3
55	6	7	-1.49	1.18	.50	-.6	.25	-.3
60	4	7	.42	.87	.50	-1.5	.44	-1.3
67	4	7	.42	.87	.50	-1.5	.44	-1.3
68	4	7	.42	.87	.50	-1.5	.44	-1.3
306	5	6	-1.50	1.19	.46	-.7	.28	-.5
37	2	6	1.57	1.00	.42	-1.3	.34	-.9
35	3	7	1.24	.88	.41	-1.7	.37	-1.3
36	3	7	1.24	.88	.41	-1.7	.37	-1.3

38	3	7	1.24	.88	.41	-1.7	.37	-1.3
40	3	7	1.24	.88	.41	-1.7	.37	-1.3
41	3	7	1.24	.88	.41	-1.7	.37	-1.3
42	33	7	1.24	.88	.41	-1.7	.37	-1.3
43	3	7	1.24	.88	.41	-1.7	.37	-1.3
243	3	4	-.95	1.34	.36	-.9	.27	-.5
Mean S.D.	4.3 2.2	6.6 2.3	-.31 1.58	1.19 .43	1.00 .35	.1 .8	1.03 .68	.1 .8

Table 4 depicts the "person" reliability and the "item" reliability using the statistical Package WINSTEP[1]. The top table is the summary of 15 students and bottom table is the summary of 322 questions from the study guide.

Table 4

Summary of 15 Students and 322 questions

Student	Raw Score	Count	Measure	Model Error	Infit MNSQ	Infit ZSTD	Outfit MNSQ	Outfit ZSTD
MEAN	117.7	183.1	.42	.24	.96	-.2	.99	.0
S.D.	83.8	105.9	1.18	.09	.18	1.5	.39	1.6
MAX.	275.0	346.0	2.65	.47	1.26	2.2	2.02	2.6
MIN.	22.0	42.0	-1.43	.14	.49	-3.0	.38	-2.9
REAL	RMSE	.26	ADJ.SD	1.15	SEPARATION	4.41	RELIABILITY	.95
MODEL	RMSE	.26	ADJ.SD	1.15	SEPARATION	4.50	RELIABILITY	.95

[1] WINSTEP V3.68.2

Question	Raw Score	Count	Measure	Model Error	Infit MNSQ	Infit ZSTD	Outfit MNSQ	Outfit ZSTD
MEAN	4.2	7.0	.00	.98	1.00	.1	1.03	.0
S.D.	2.1	2.2	1.15	.18	.35	.8	.68	.8
MAX	9.0	11.0	2.75	1.41	1.92	2.3	5.22	2.7
MIN.	1.0	2.0	-2.20	.66	.36	-1.7	.25	-1.4
REAL	RMSE	1.07	ADJ.SD	.43	SEPARATION	.41	RELIABILITY	.14
MODEL	RMSE	.99	ADJ.SD	.58	SEPARATION	.58	RELIABILITY	.25

Table 5
Student Ability for U. S. History Classroom

Student	Tried	Right	Percent	Ability	S.E.	Marginal Prob
3	38	32	84.21	2.7184	.03907	0.000000
4	154	76	49.35	0.1070	0.1461	0.000000
5	71	19	26.76	-0.681	0.3007	0.000000
6	235	123	52.34	0.5960	0.1486	0.000000
7	198	112	56.57	0.5100	0.1555	0.000000
8	141	75	53.19	0.5474	0.1905	0.000000
9	269	219	81.41	2.3224	0.1704	0.000000
10	143	36	25.17	-0.980	0.2055	0.000000
11	263	146	65.78	1.2171	0.1500	0.000000
12	58	46	79.31	1.8449	0.3133	0.000000
13	92	45	48.91	0.3455	0.2386	0.000000
14	47	24	51.06	0.4040	0.3447	0.000000
15	256	155	60.55	0.9823	0.1482	0.000000

Items with 100 percent correct response were deleted in the formation of the Item characteristic curve Figures. The following Figures depict each study guide question, each question's probability and ability level of the students. The ability level for each item is denoted with "b".

Figure 1. Item Characteristic Curve: Item 0008

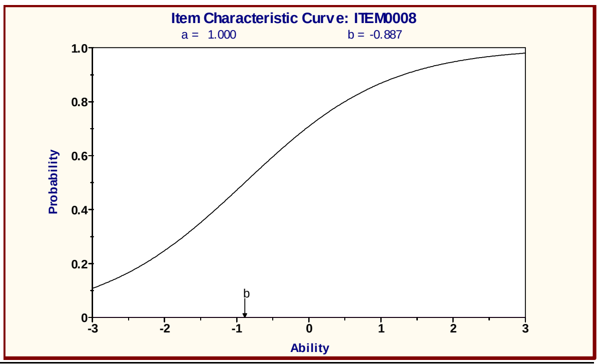


Figure 2. Item Characteristic Curve: Item 0010

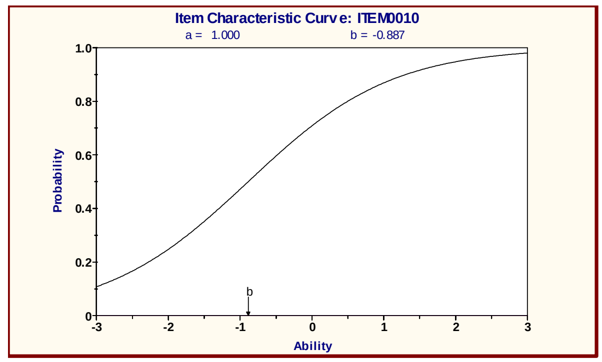


Figure 3. Item Characteristic Curve: Item 0011

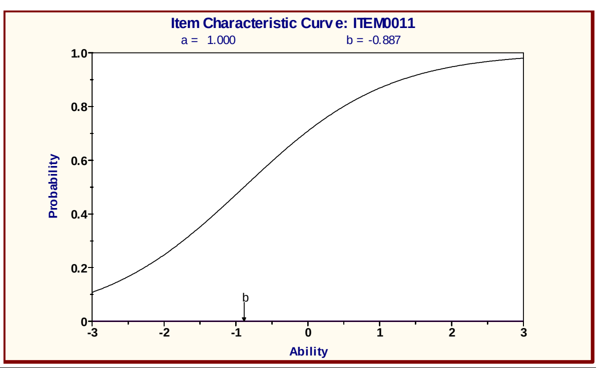


Figure4. Item Characteristic Curve: Item 0014

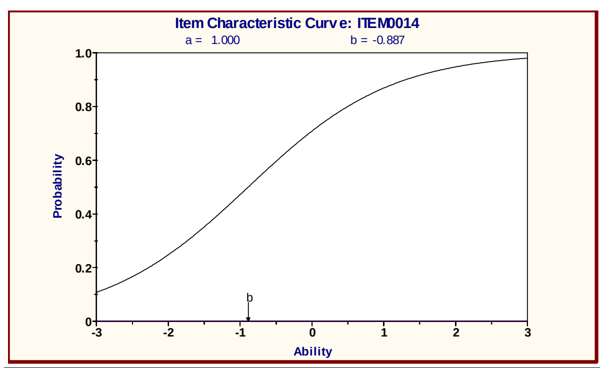


Figure 5. Item Characteristic Curve: Item 0015

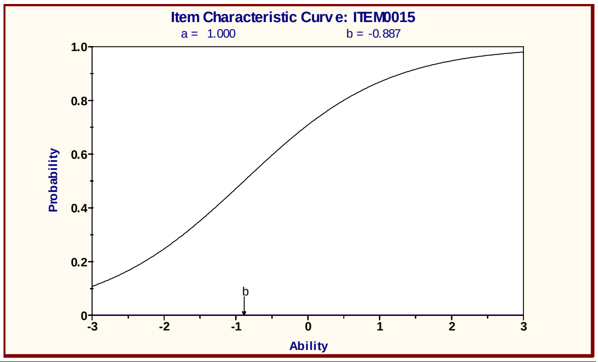


Figure 6. Item Characteristic Curve: Item 0016

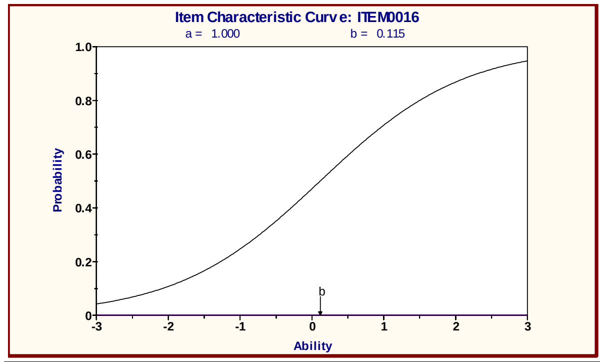


Figure 7. Item Characteristic Curve: Item 0017

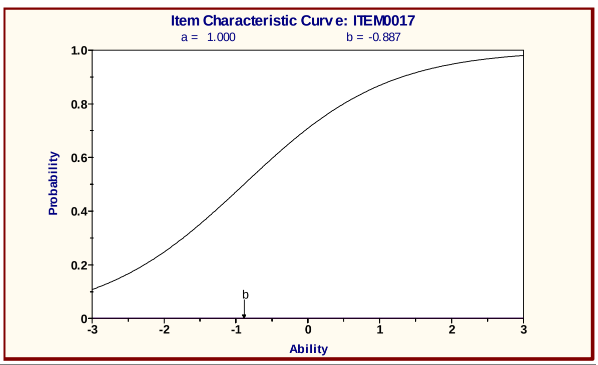


Figure 8. Item Characteristic Curve: Item 0018

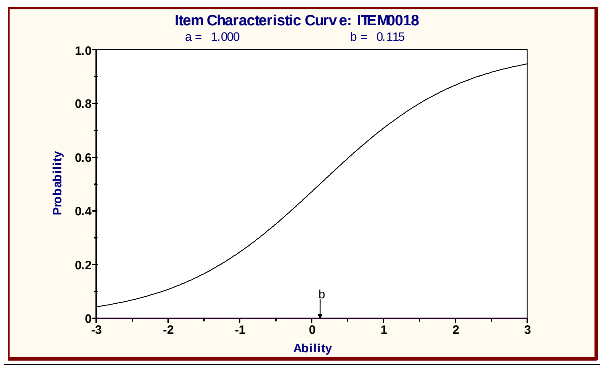


Figure 9. Item Characteristic Curve: Item 0019

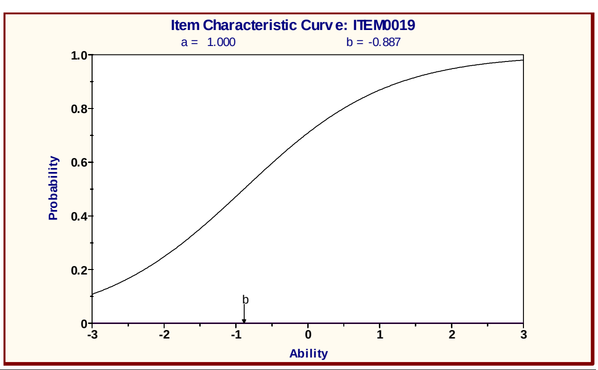


Figure 10. Item Characteristic Curve: Item 0020

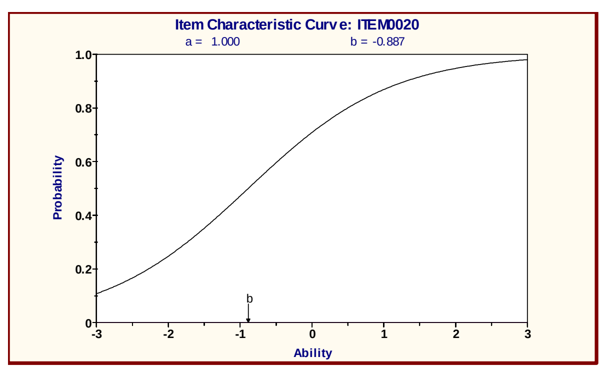


Figure 11 Item Characteristic Curve: Item 0021

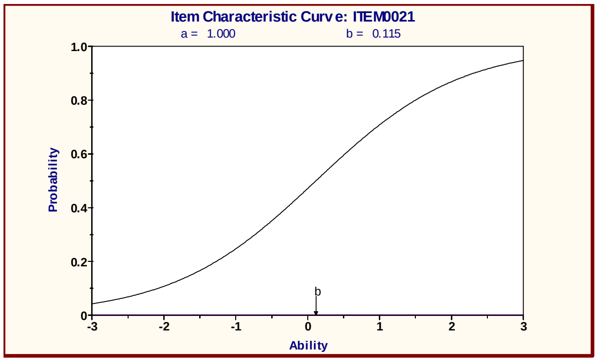


Figure 12 Item Characteristic Curve: Item 0022

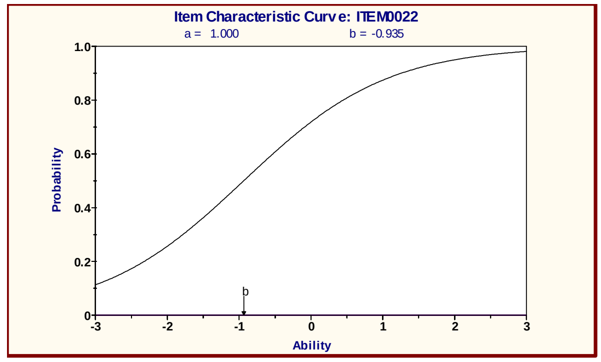


Figure 13. Item Characteristic Curve: Item 0023

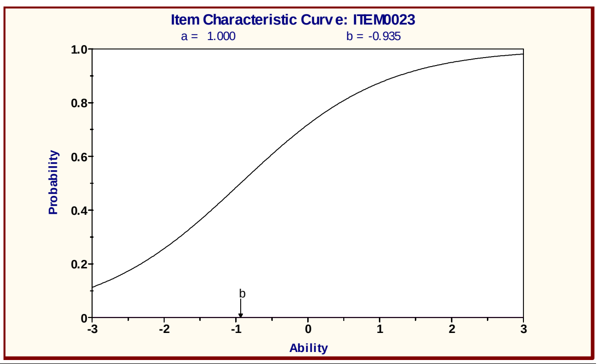


Figure 14. Item Characteristic Curve: Item 0024

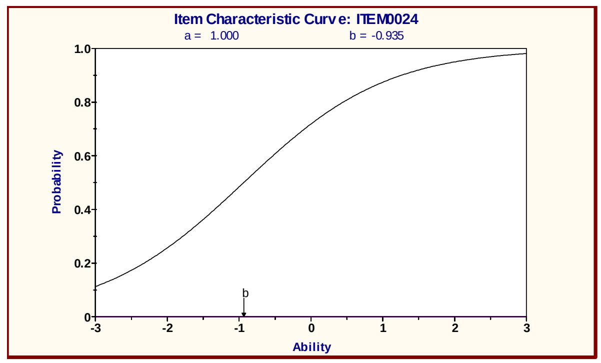


Figure 15. Item Characteristic Curve: Item 0025

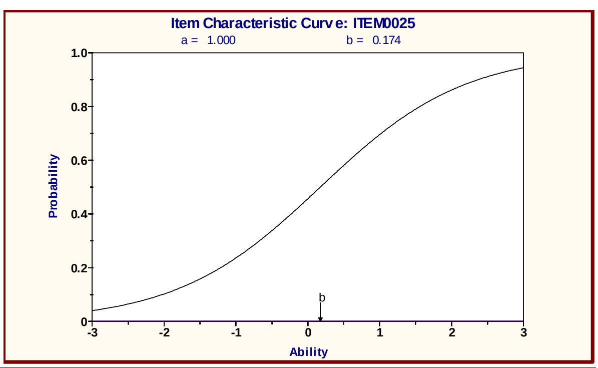


Figure 16. Item Characteristic Curve: Item 0026

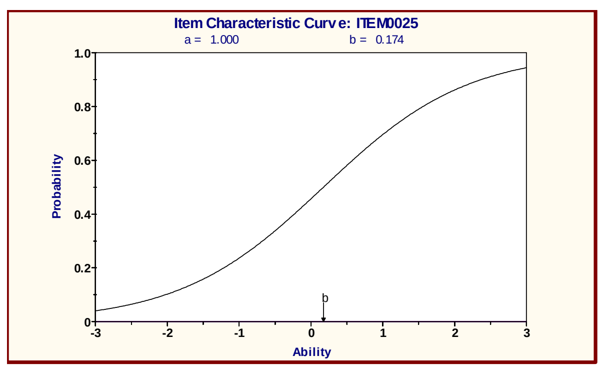


Figure 17. Item Characteristic Curve: Item 0027

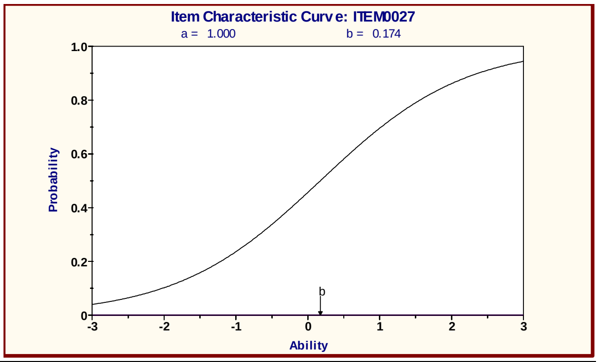


Figure 18. Item Characteristic Curve: Item 0028

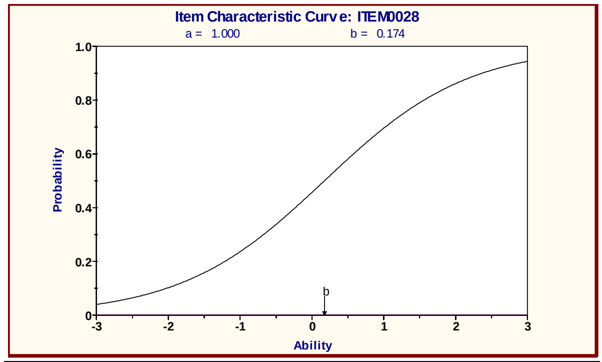


Figure 19. Item Characteristic Curve: Item 0029

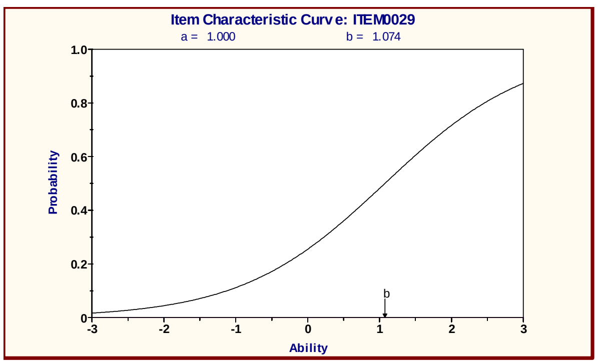


Figure 20. Item Characteristic Curve: Item 0030

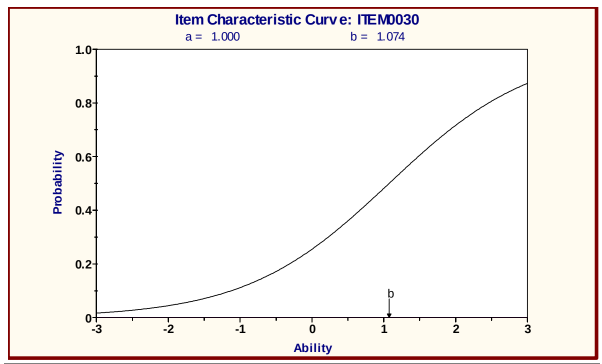


Figure 21. Item Characteristic Curve: Item 0031

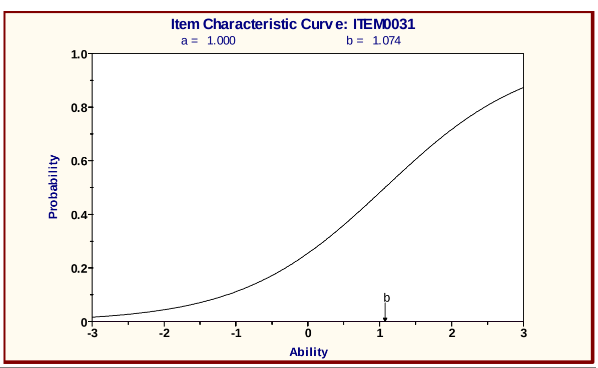


Figure 22. Item Characteristic Curve: Item 0032

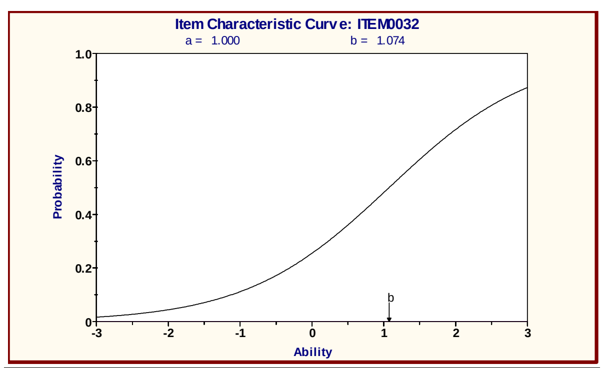


Figure 23. Item Characteristic Curve: Item 0033

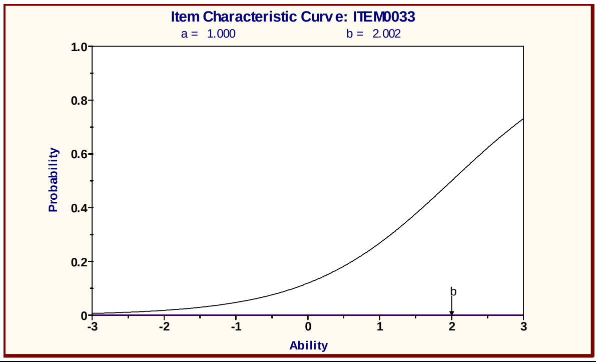
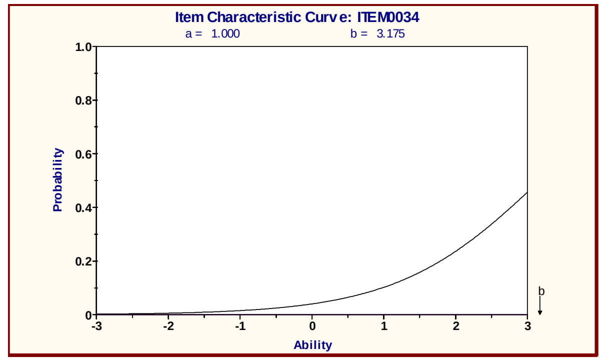


Figure 24. Item Characteristic Curve: Item 0034



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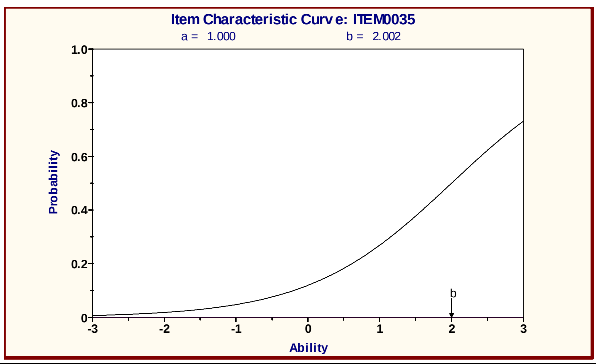


Figure 26. Item Characteristic Curve: Item 0036

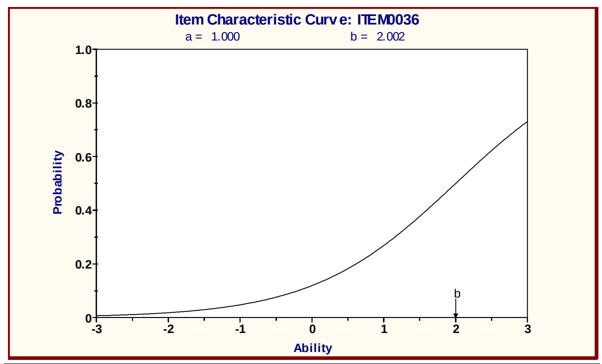


Figure 27. Item Characteristic Curve: Item 0037

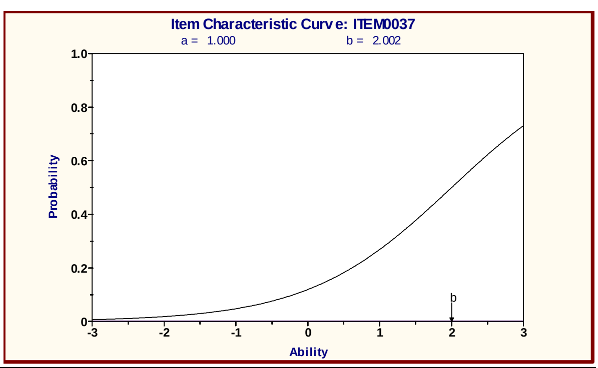


Figure 28. Item Characteristic Curve: Item 0038

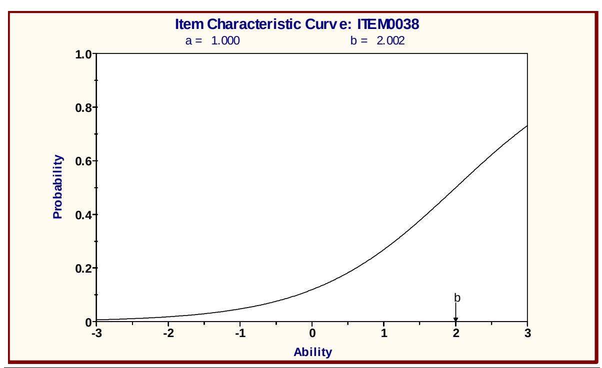
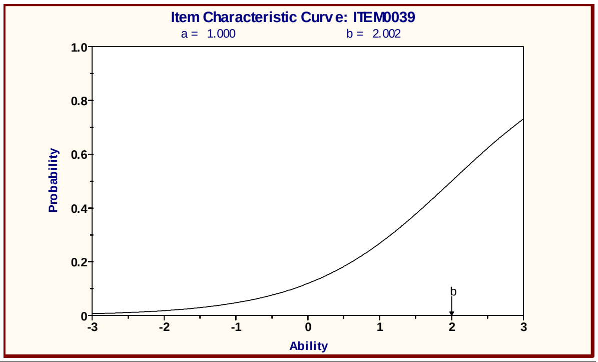


Figure 29. Item Characteristic Curve: Item 0039



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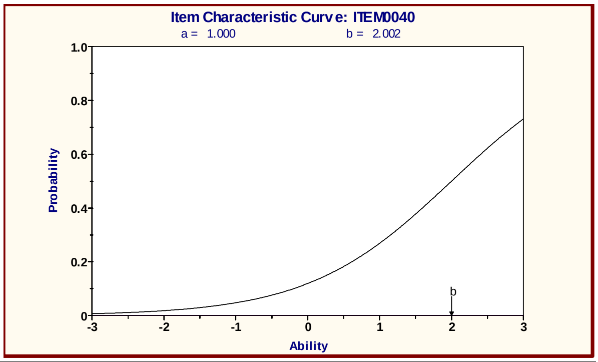

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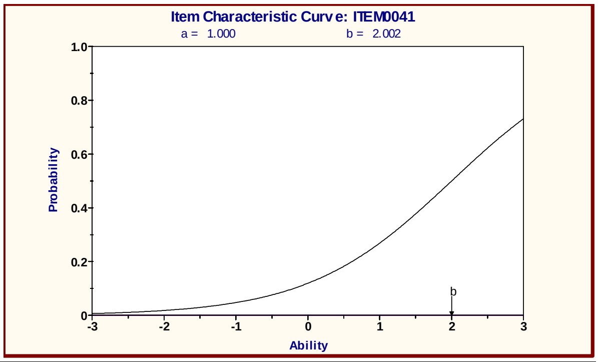


Figure 32. Item Characteristic Curve: Item 0042

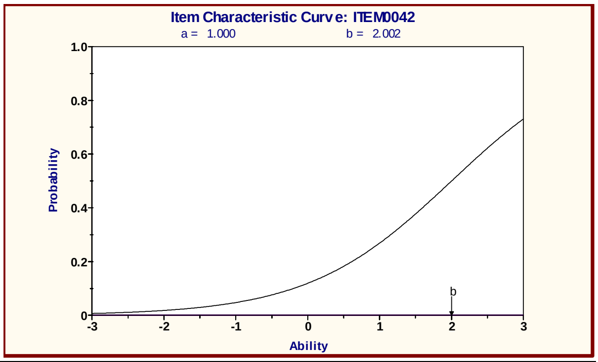
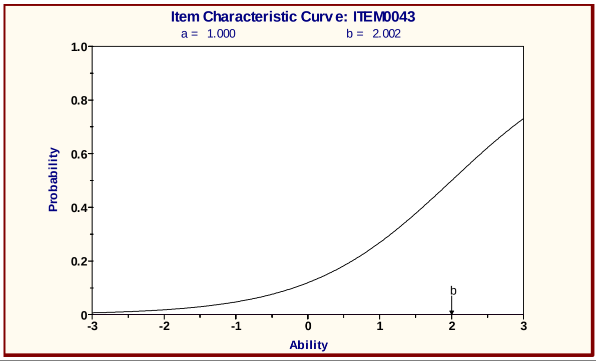


Figure 33. Item Characteristic Curve: Item 0043



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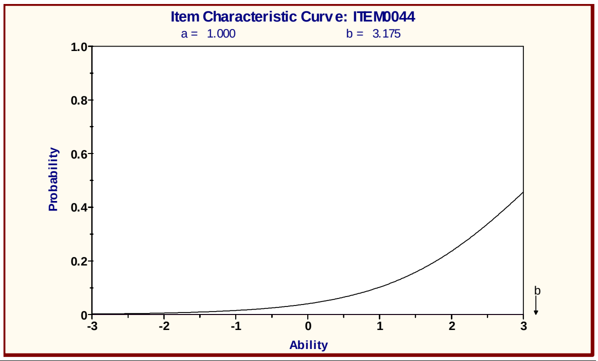

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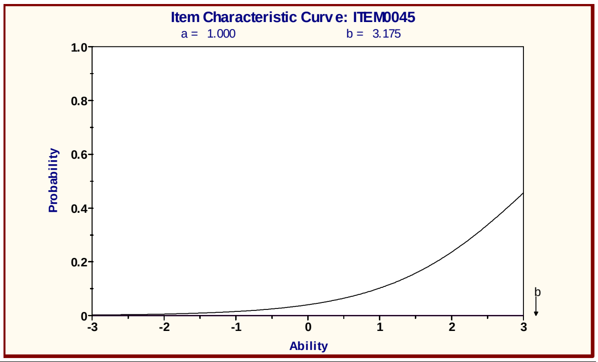


Figure 36. Item Characteristic Curve: Item 0053

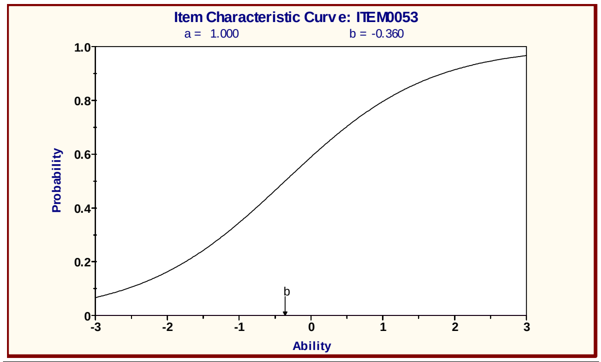


Figure 37. Item Characteristic Curve: Item 0054

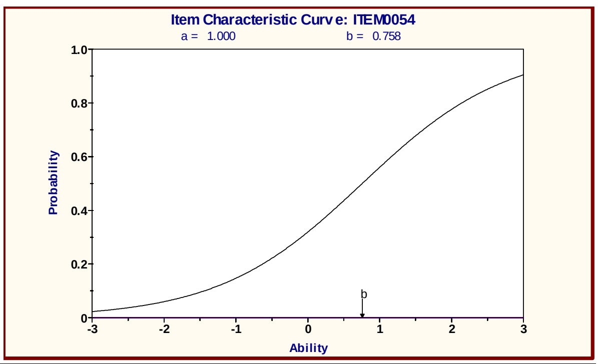
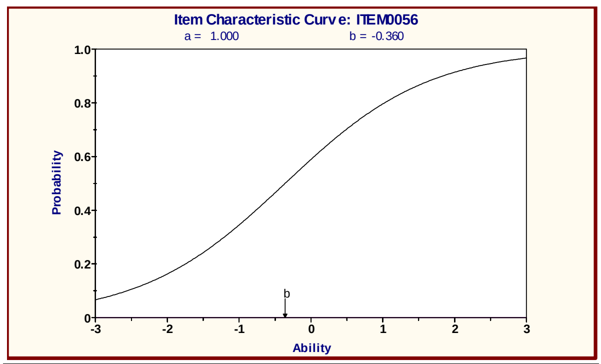


Figure 38. Item Characteristic Curve: Item 0056



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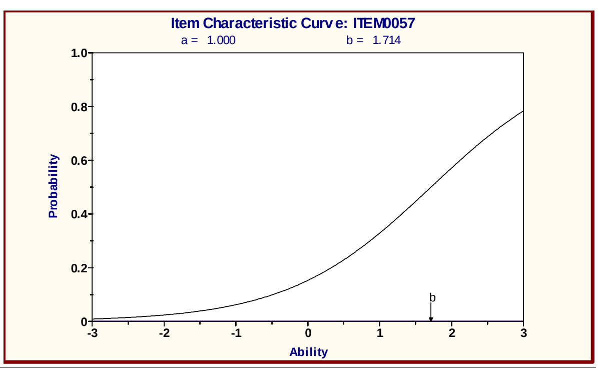
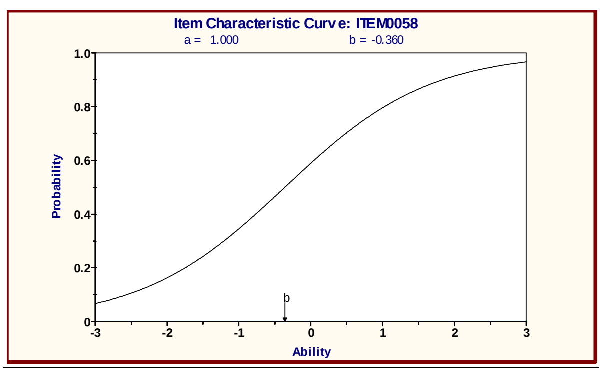


Figure 40. Item Characteristic Curve: Item 0058



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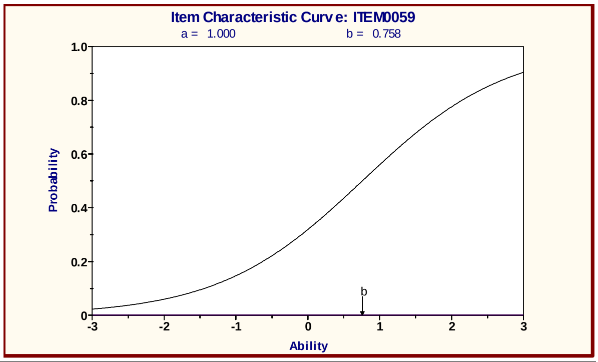


Figure 42. Item Characteristic Curve: Item 0060

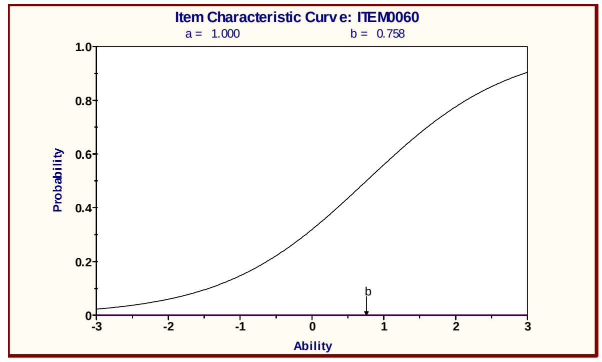


Figure 43. Item Characteristic Curve: Item 0061

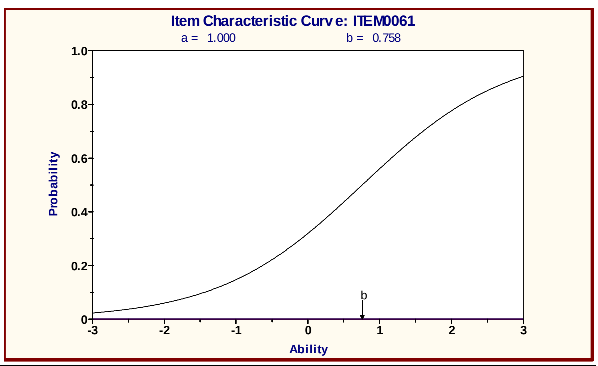
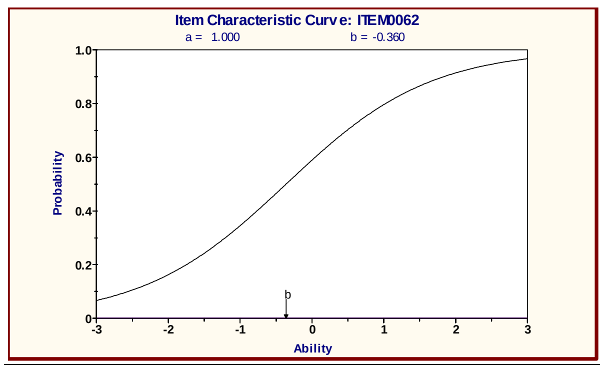


Figure 44. Item Characteristic Curve: Item 0062



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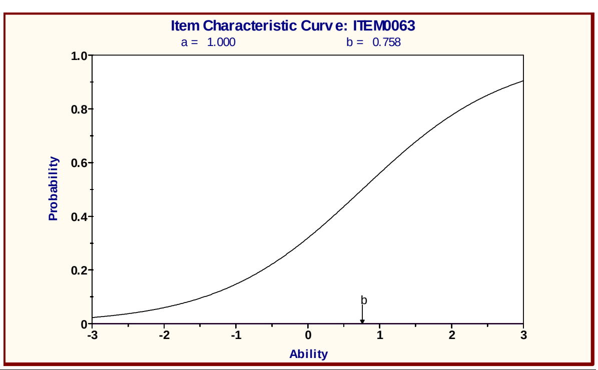

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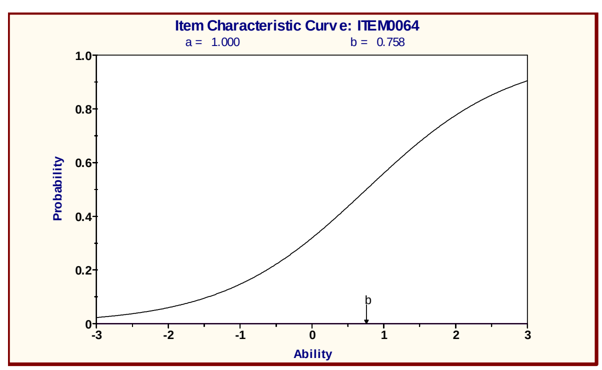
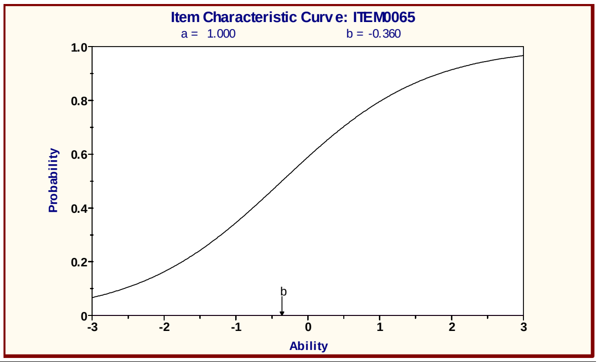


Figure 47. Item Characteristic Curve: Item 0065



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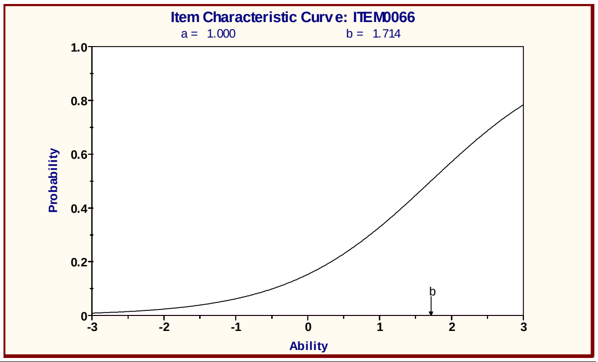
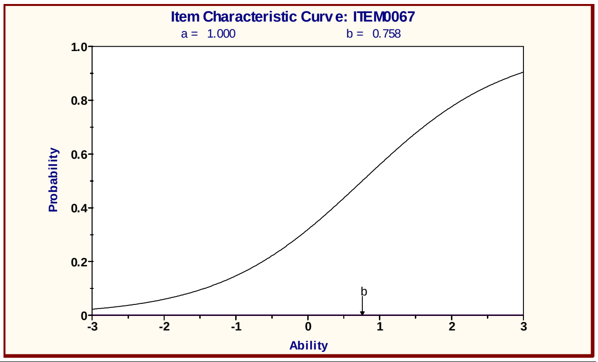


Figure 49. Item Characteristic Curve: Item 0067



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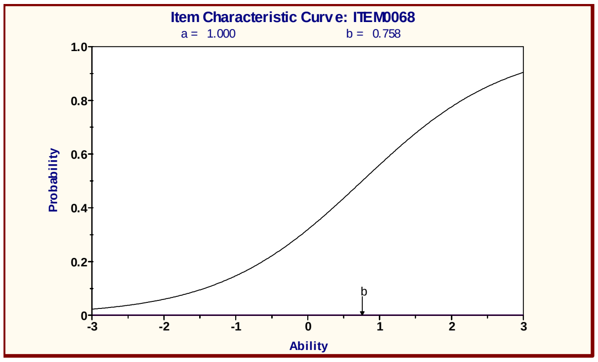

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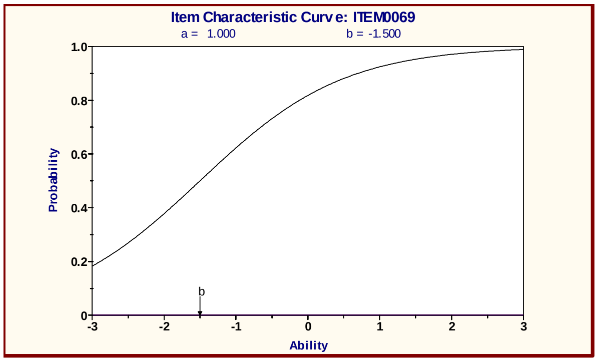

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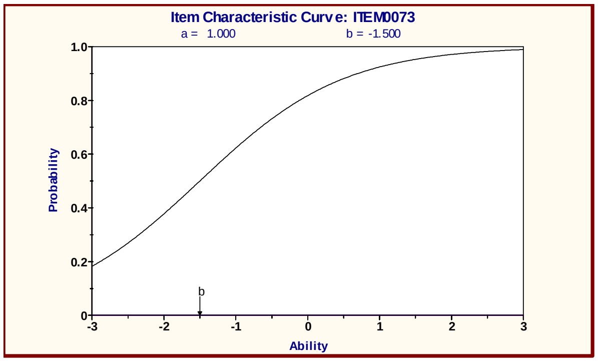

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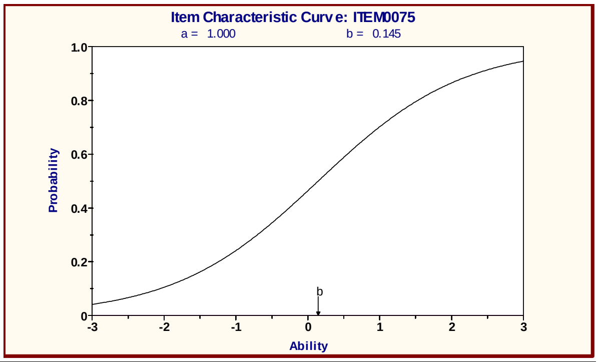

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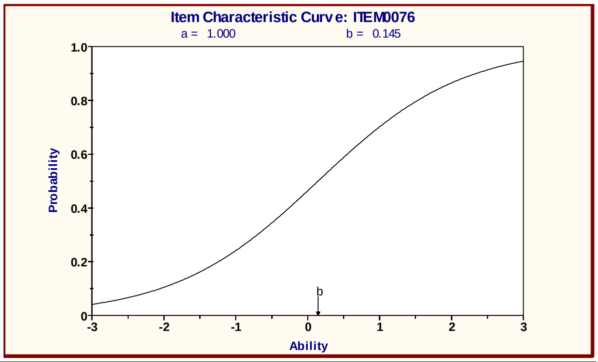

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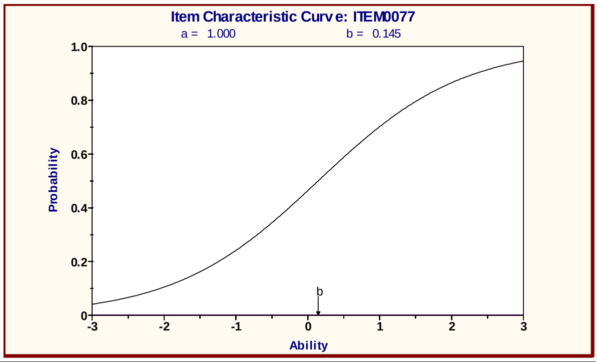

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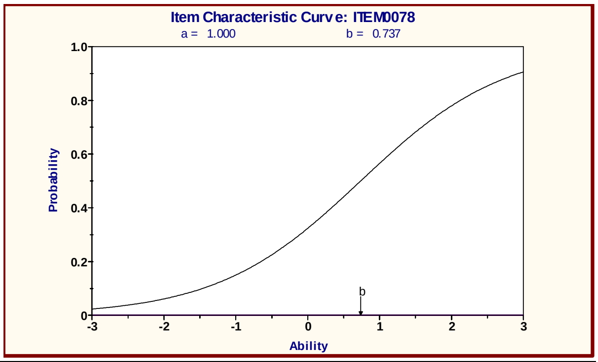

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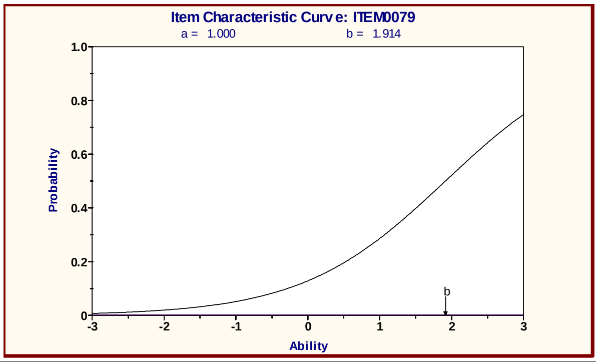

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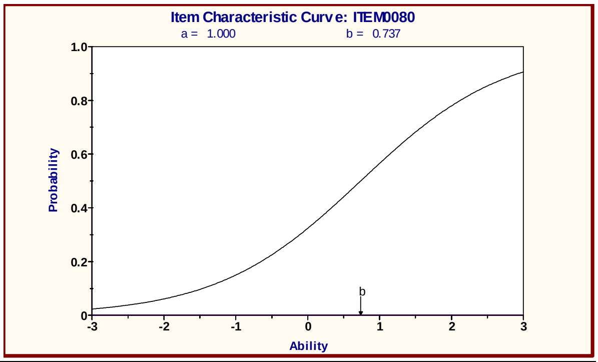

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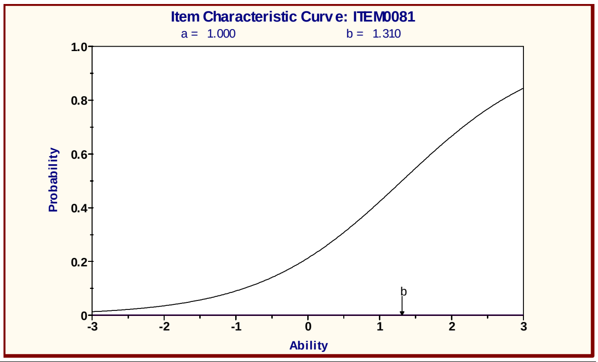
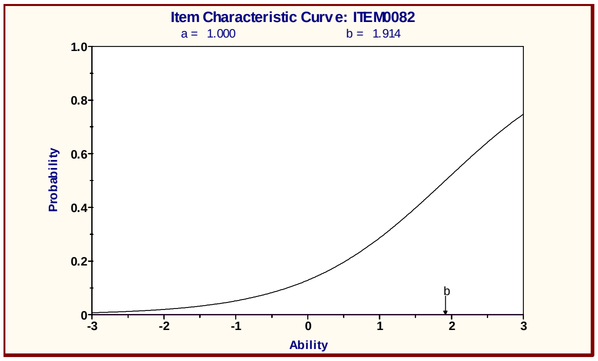


Figure 60. Item Characteristic Curve: Item 0082



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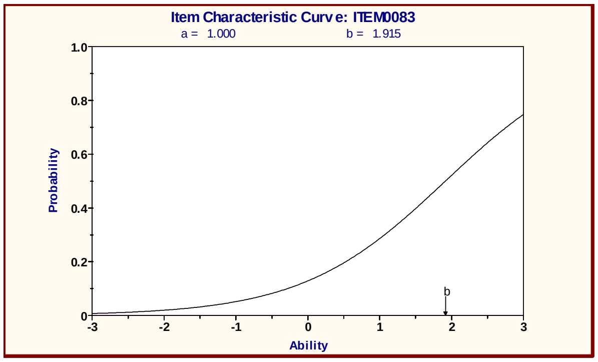

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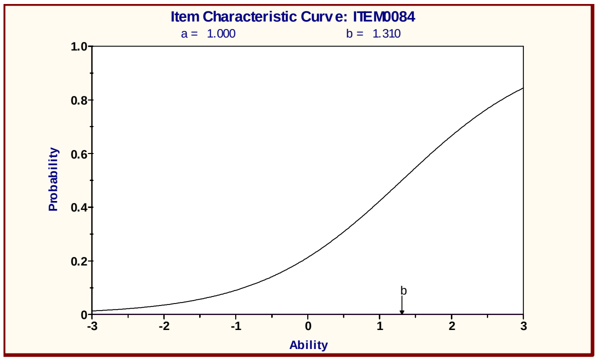

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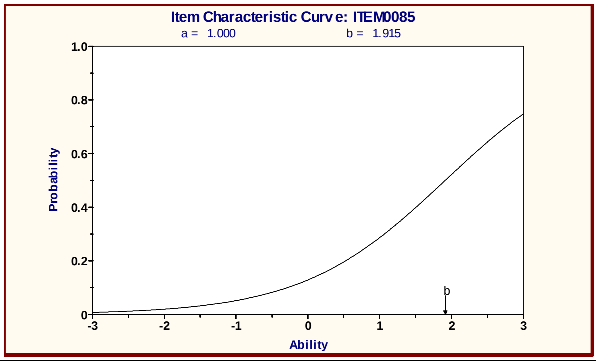

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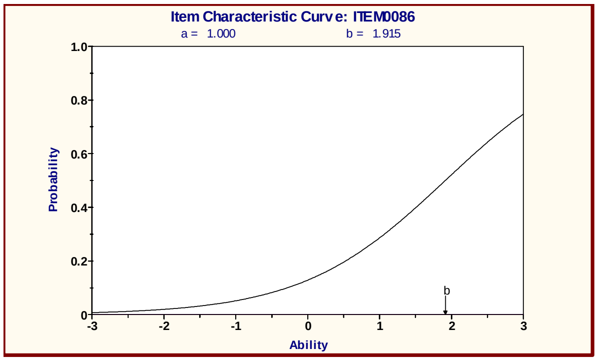

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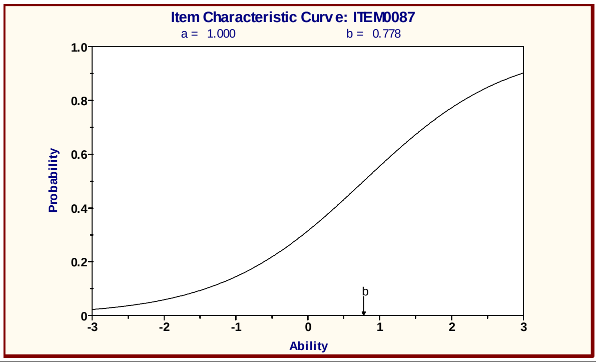

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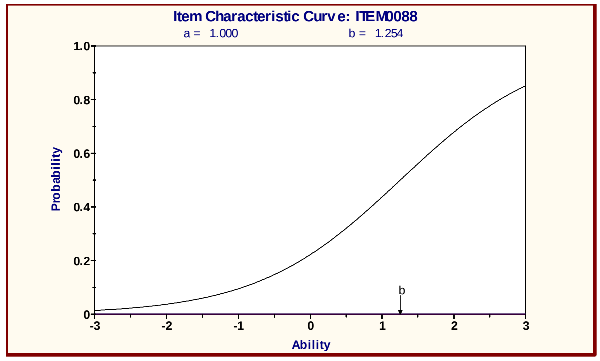

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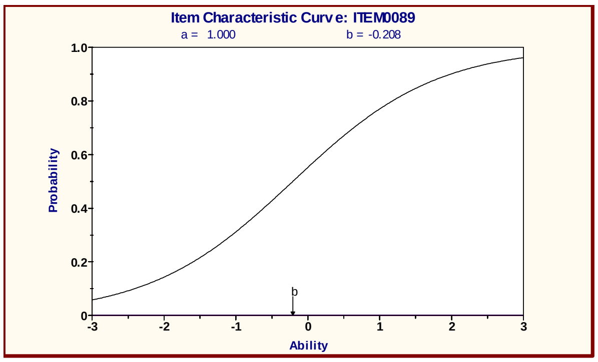

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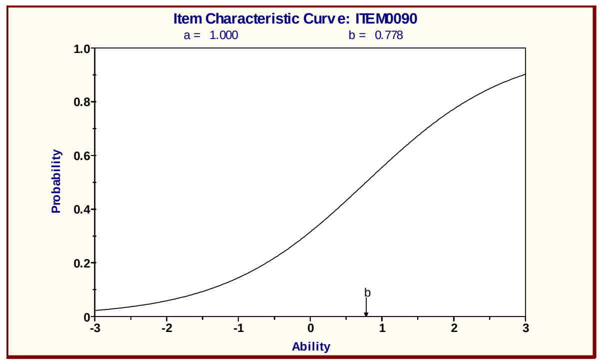


Figure 69. Item Characteristic Curve: Item 0091

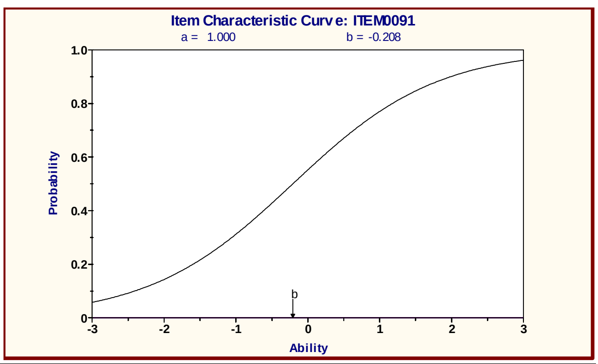
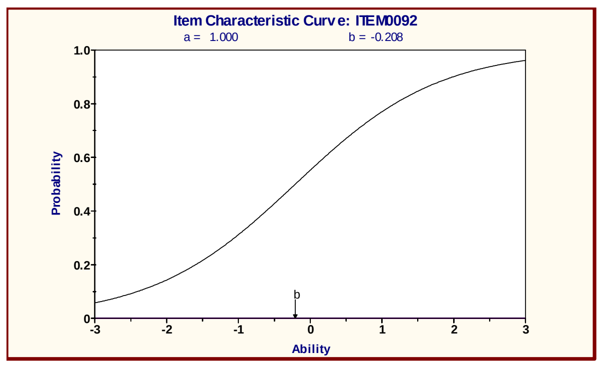


Figure 70. Item Characteristic Curve: Item 0092



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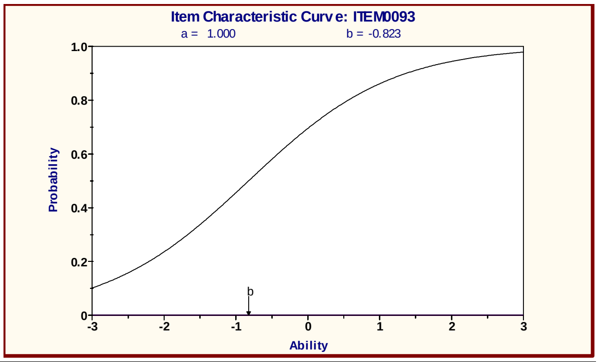

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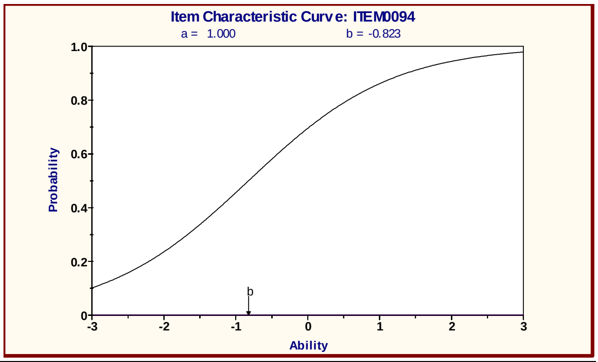

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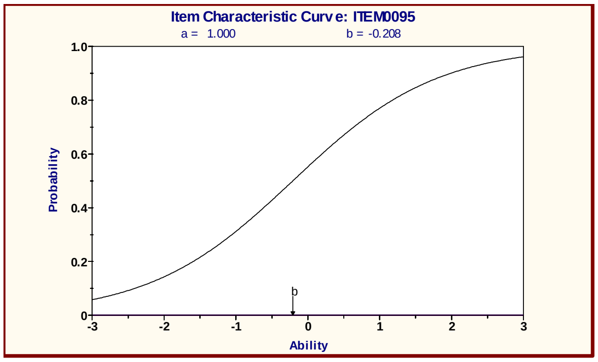

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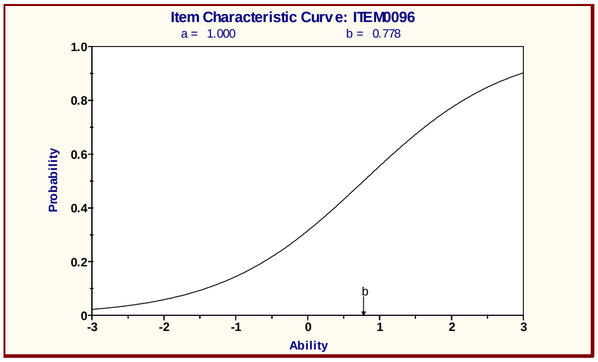

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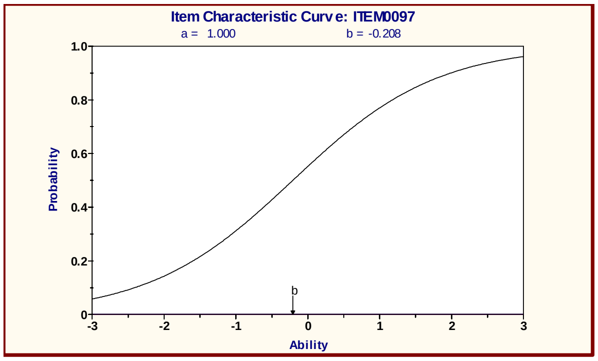

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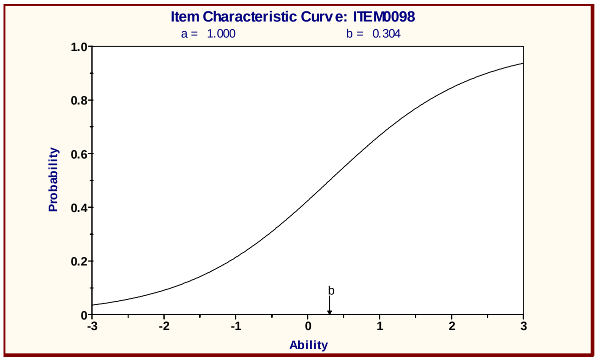

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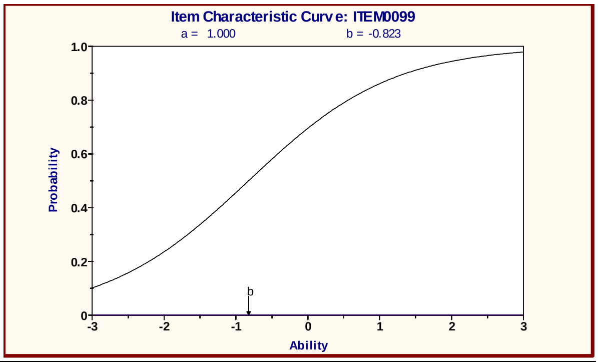

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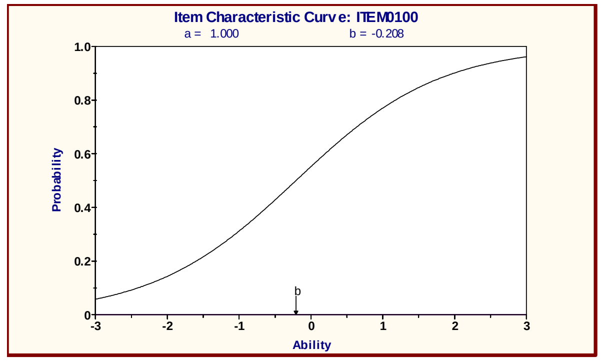

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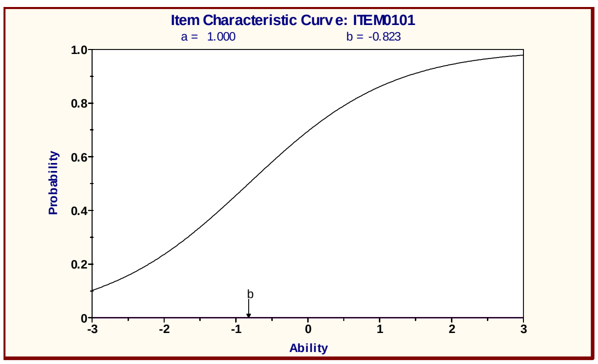

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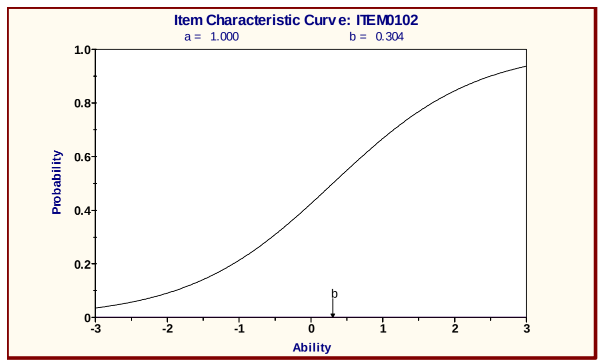


Figure 81. Item Characteristic Curve: Item 0103

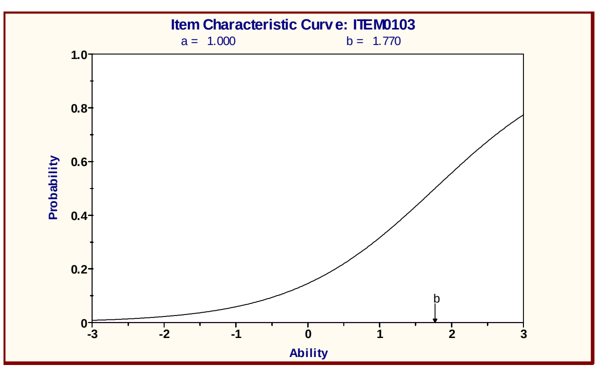


Figure 82. Item Characteristic Curve: Item 0104

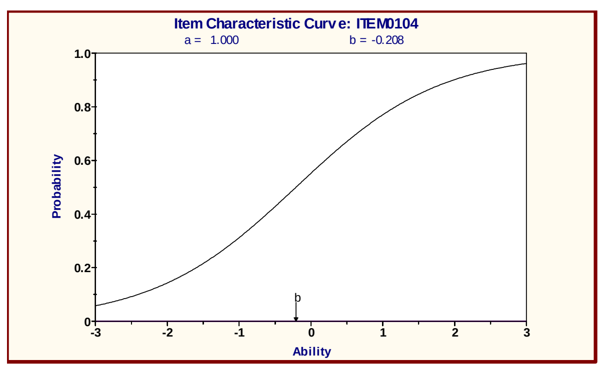


Figure 83. Item Characteristic Curve: Item 0105

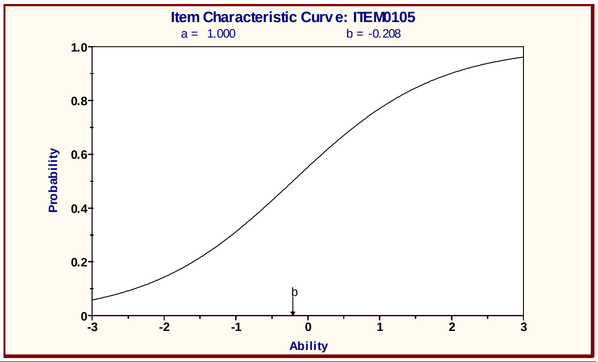


Figure 84. Item Characteristic Curve: Item 0106

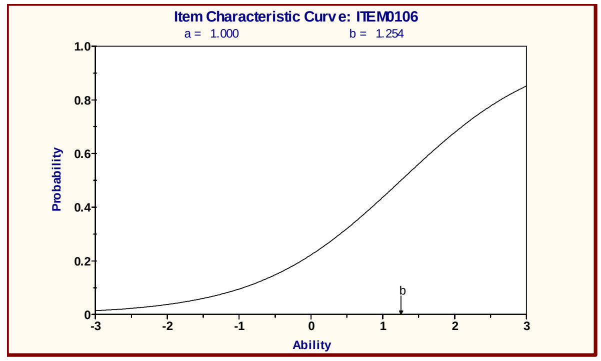


Figure 85. Item Characteristic Curve: Item 0107

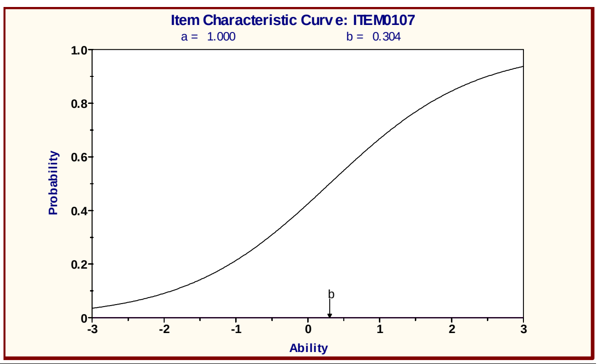


Figure 86. Item Characteristic Curve: Item 0108

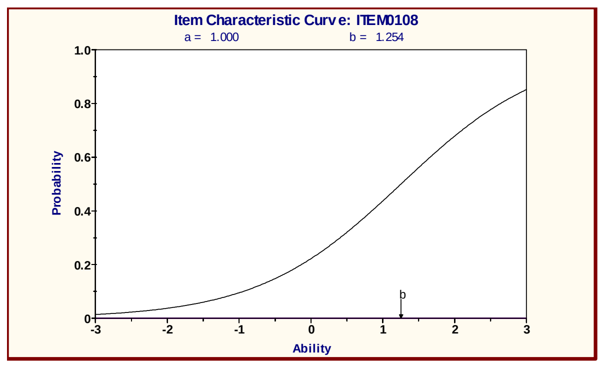


Figure 87. Item Characteristic Curve: Item 0109

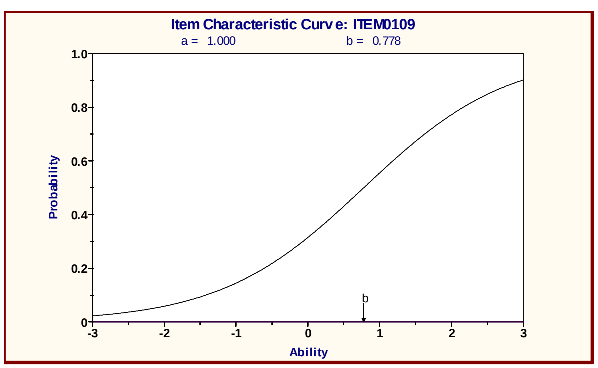


Figure 88. Item Characteristic Curve: Item 0110

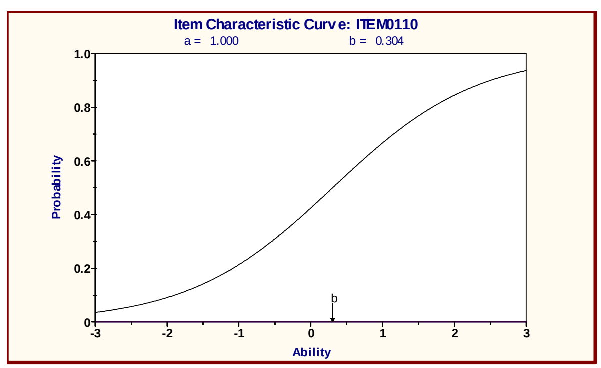


Figure 89. Item Characteristic Curve: Item 0111

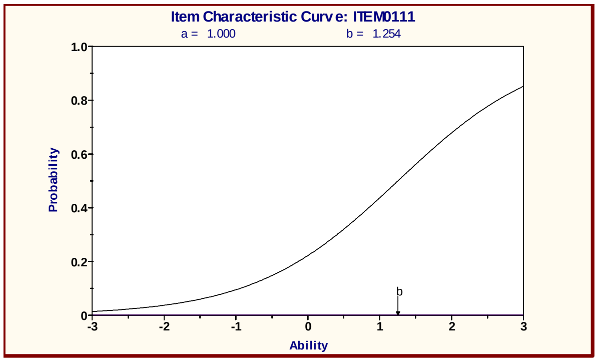


Figure 90. Item Characteristic Curve: Item 0112

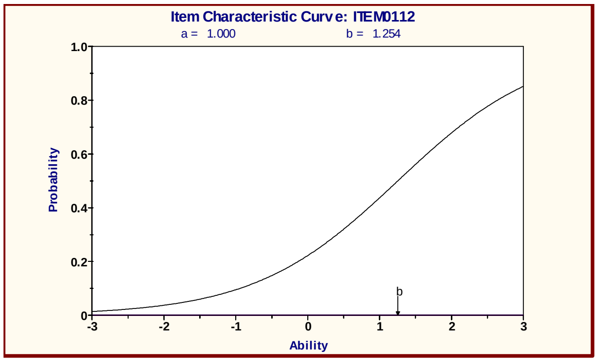


Figure 91. Item Characteristic Curve: Item 0113

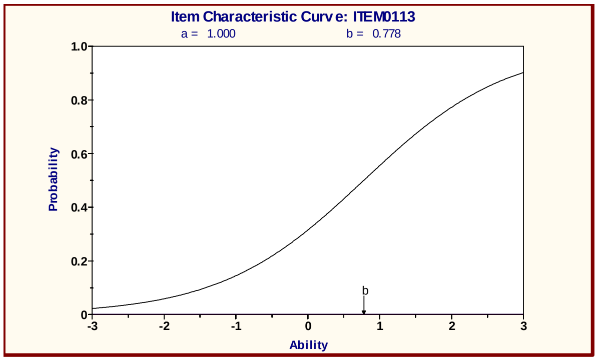


Figure 92. Item Characteristic Curve: Item 0114

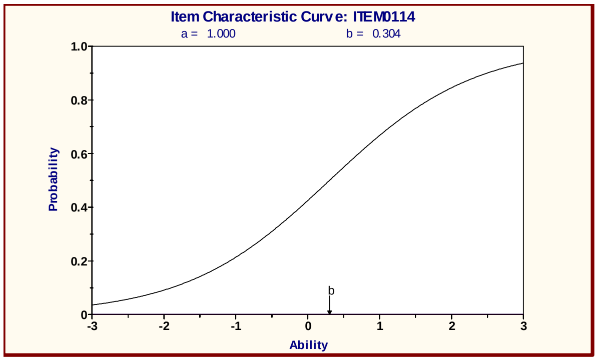


Figure 93. Item Characteristic Curve: Item 0115

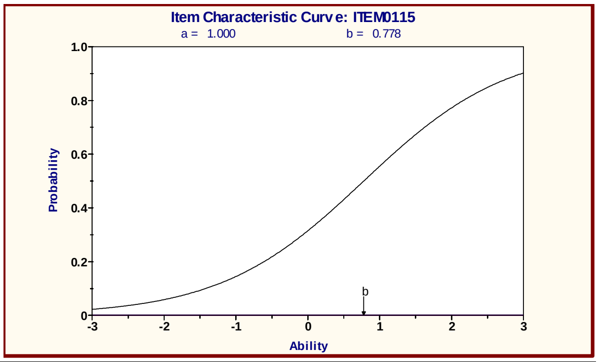


Figure 94. Item Characteristic Curve: Item 0116

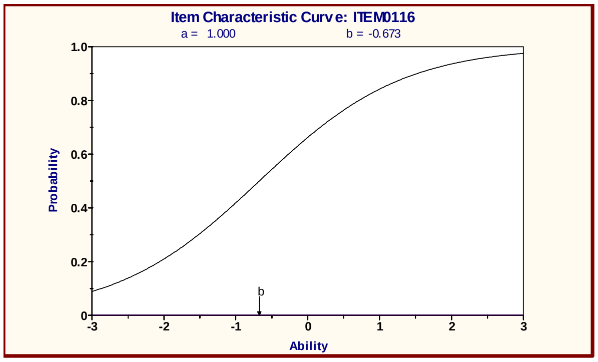


Figure 95. Item Characteristic Curve: Item 0117

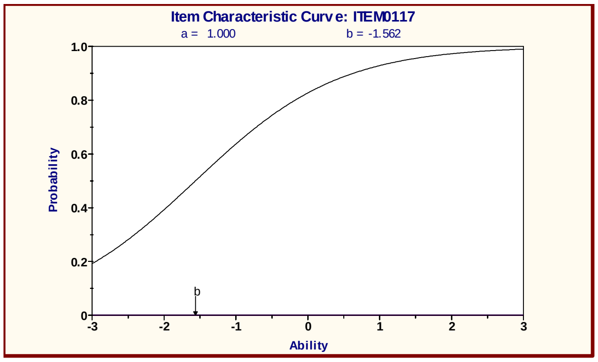


Figure 96. Item Characteristic Curve: Item 0118

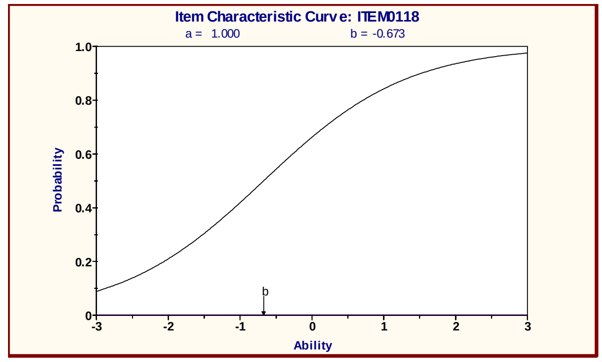


Figure 97. Item Characteristic Curve: Item 0120

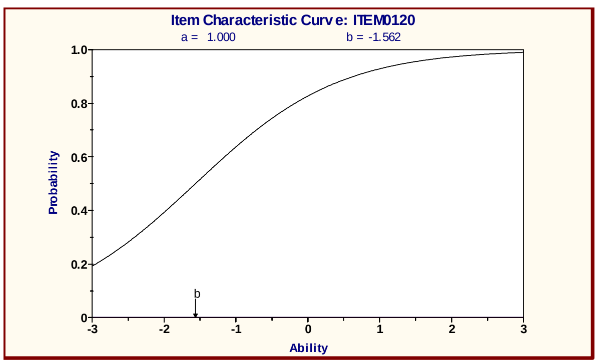


Figure 98. Item Characteristic Curve: Item 0122

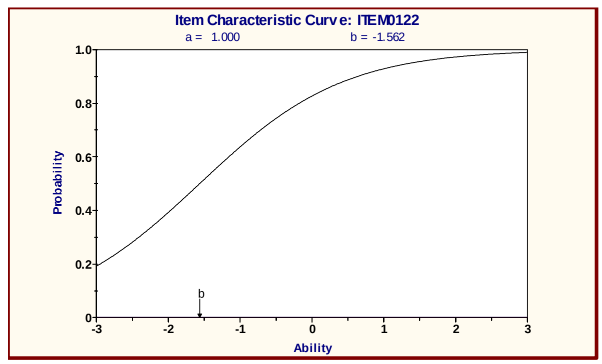


Figure 99. Item Characteristic Curve: Item 0123

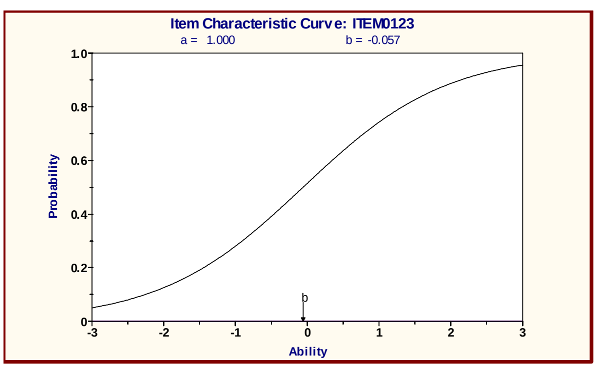


Figure 100. Item Characteristic Curve: Item 0124

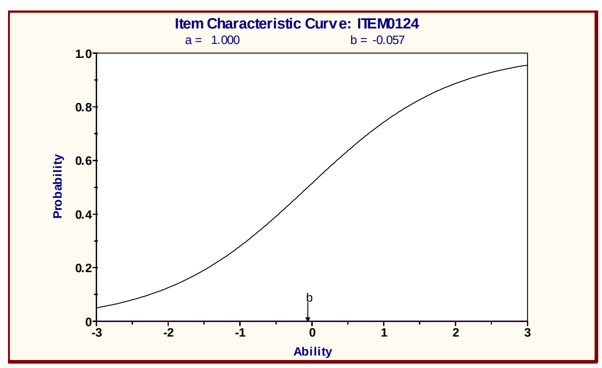


Figure 101. Item Characteristic Curve: Item 0125

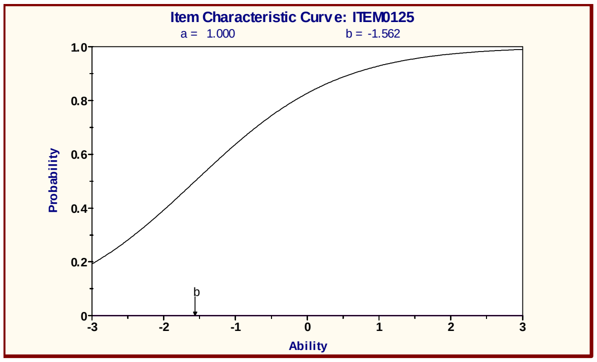


Figure 102. Item Characteristic Curve: Item 0126

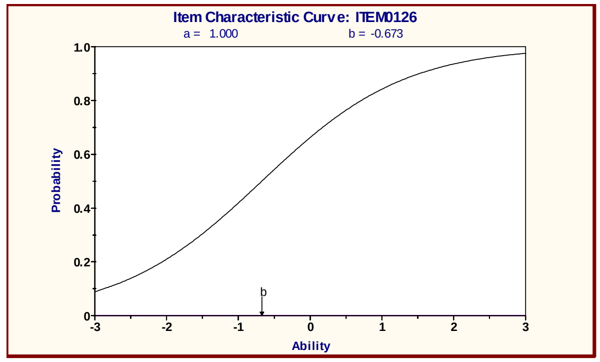


Figure 103. Item Characteristic Curve: Item 0127

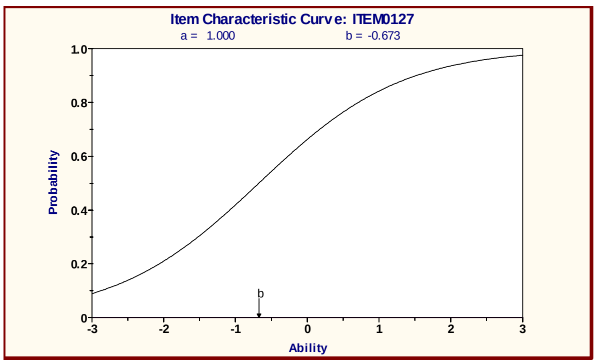


Figure 104. Item Characteristic Curve: Item 0128

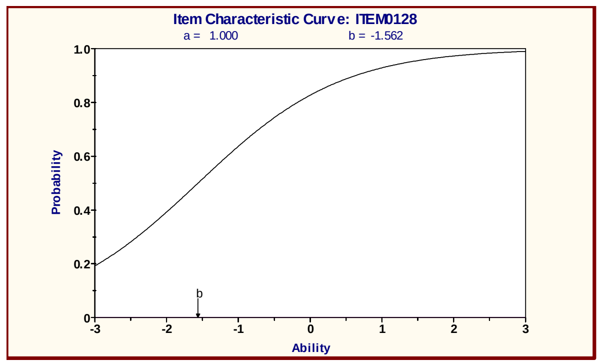


Figure 105. Item Characteristic Curve: Item 0129

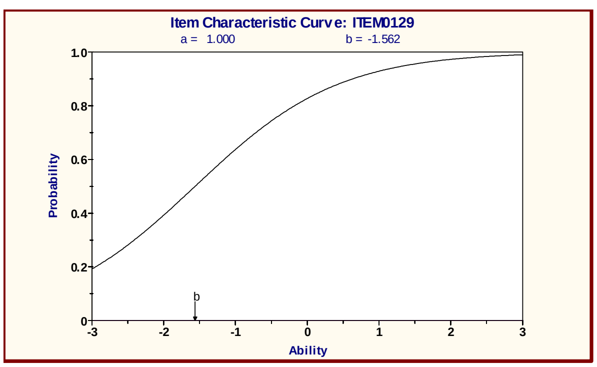


Figure 106. Item Characteristic Curve: Item 0130

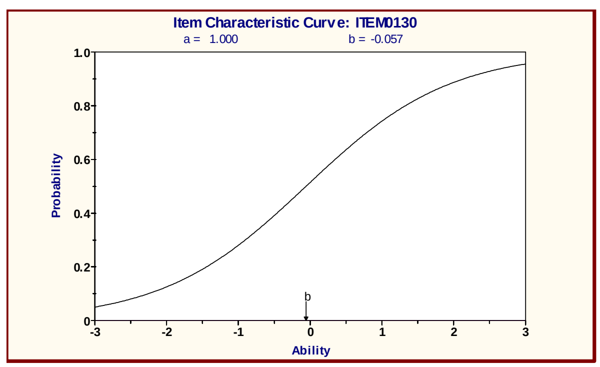


Figure 107. Item Characteristic Curve: Item 0131

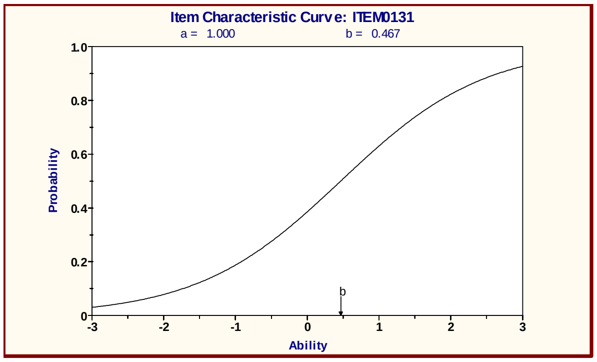


Figure 108. Item Characteristic Curve: Item 0132

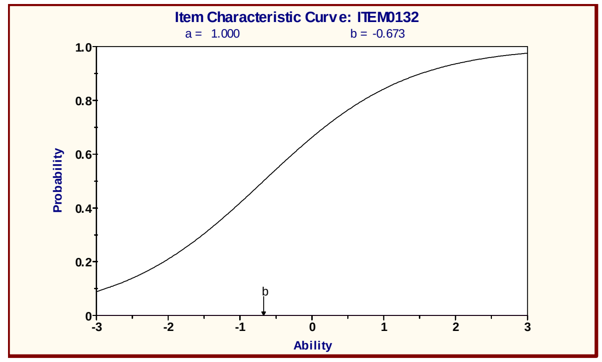


Figure 109. Item Characteristic Curve: Item 0133

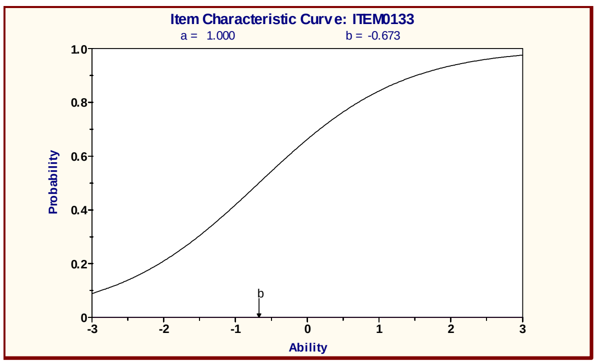


Figure 110. Item Characteristic Curve: Item 0134

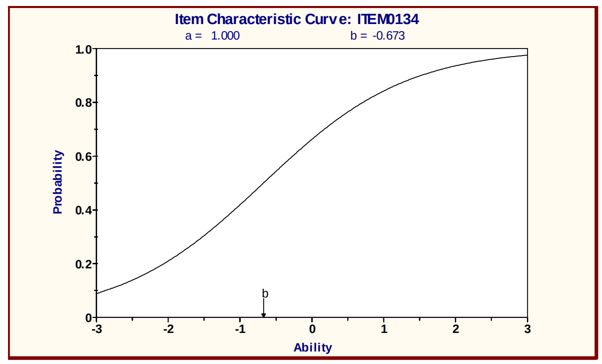


Figure 111. Item Characteristic Curve: Item 0135

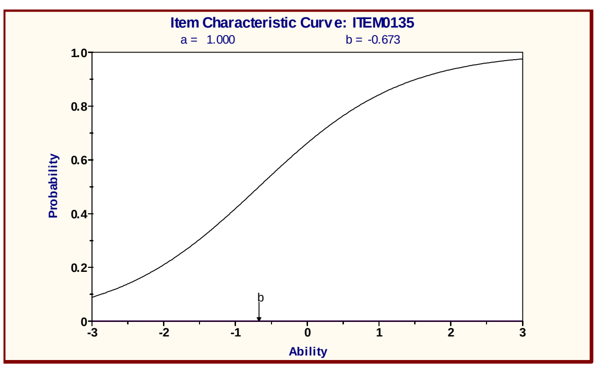


Figure 112. Item Characteristic Curve: Item 0136

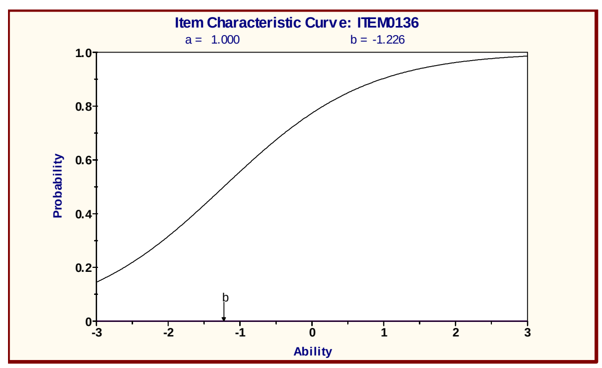


Figure 113. Item Characteristic Curve: Item 0138

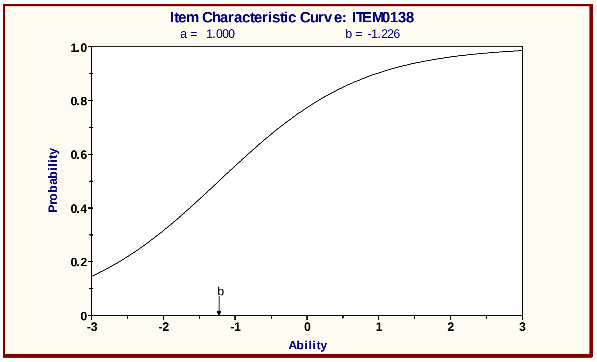
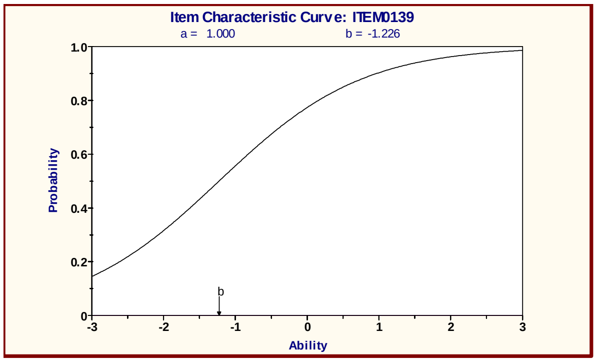


Figure 114. Item Characteristic Curve: Item 0139



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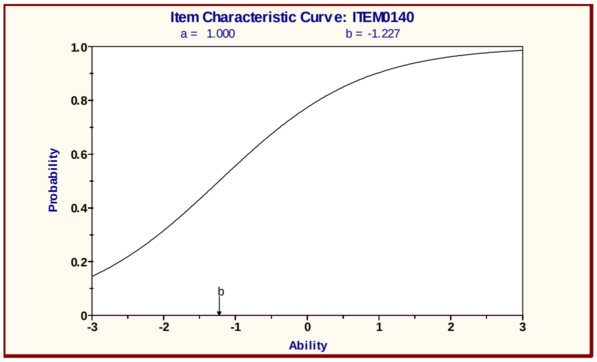


Figure 116. Item Characteristic Curve: Item 0141

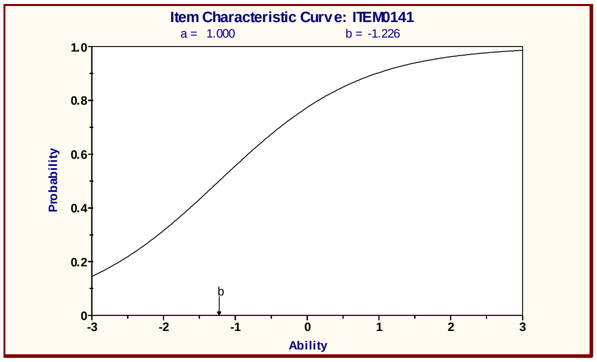


Figure 117. Item Characteristic Curve: Item 0142

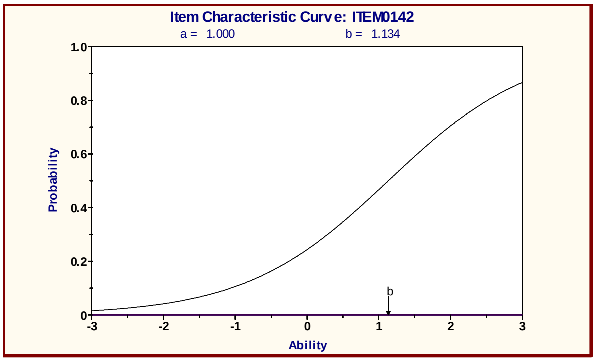


Figure 118. Item Characteristic Curve: Item 0143

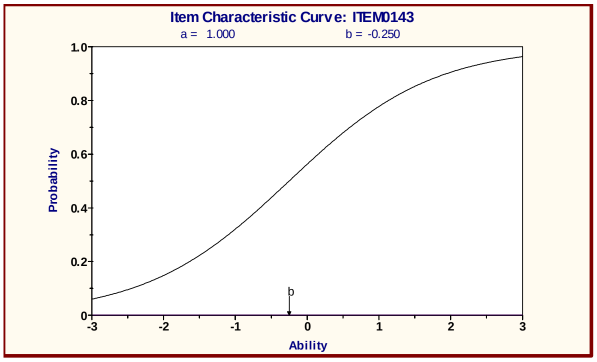


Figure 119. Item Characteristic Curve: Item 0144

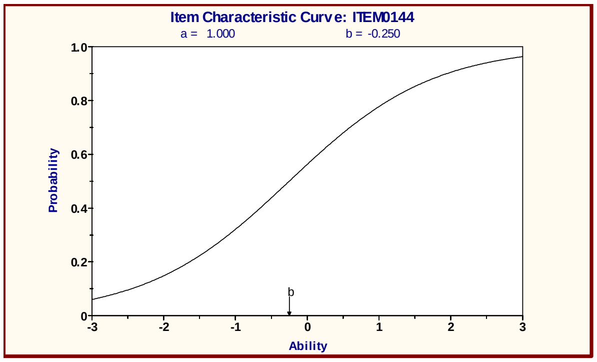


Figure 120. Item Characteristic Curve: Item 0145

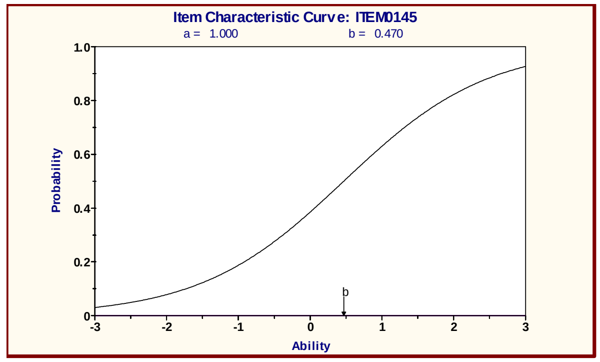


Figure 121. Item Characteristic Curve: Item 0146

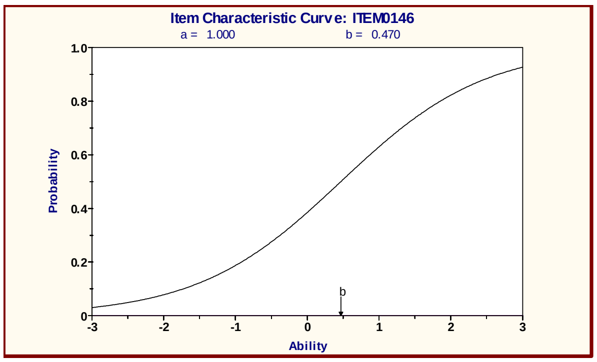


Figure 122. Item Characteristic Curve: Item 0147

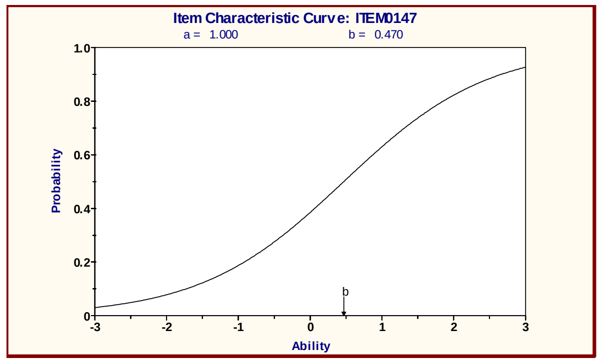


Figure 123. Item Characteristic Curve: Item 0148

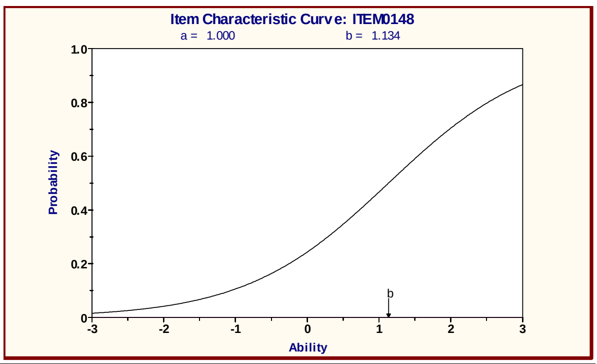


Figure 124. Item Characteristic Curve: Item 0149

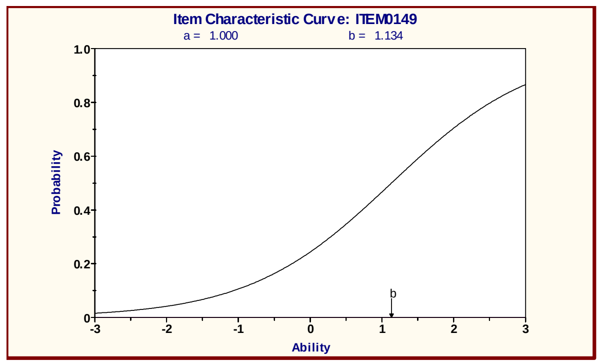


Figure 125. Item Characteristic Curve: Item 0150

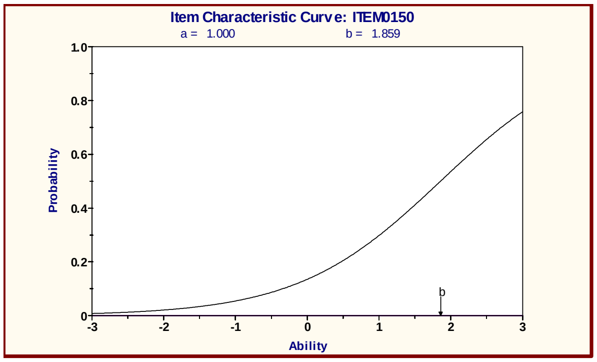


Figure 126. Item Characteristic Curve: Item 0151

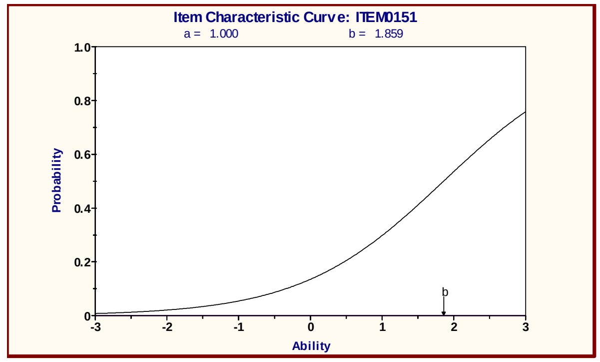


Figure 127. Item Characteristic Curve: Item 0152

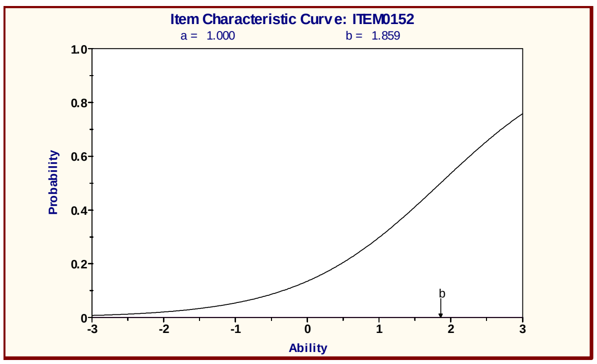


Figure 128. Item Characteristic Curve: Item 0153

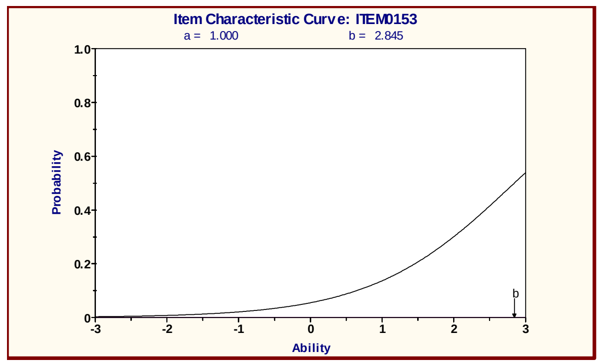


Figure 129. Item Characteristic Curve: Item 0154

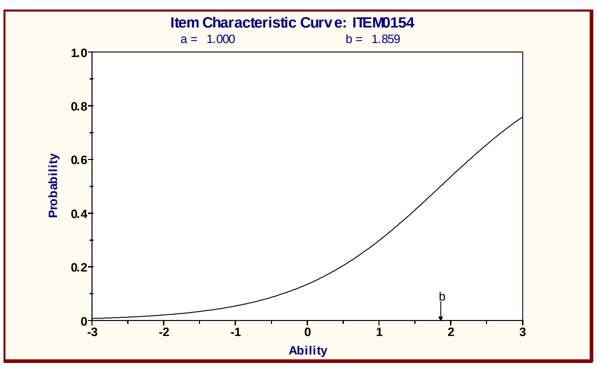


Figure 130. Item Characteristic Curve: Item 0156

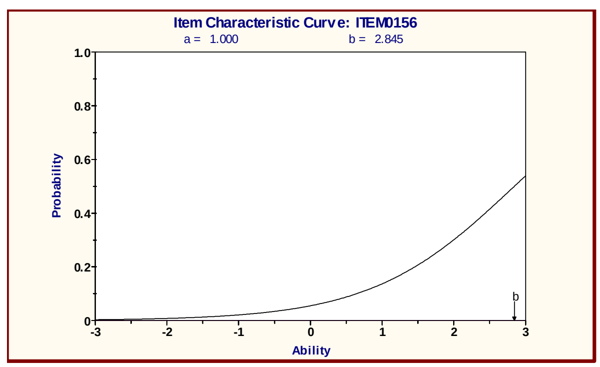


Figure 131. Item Characteristic Curve: Item 0158

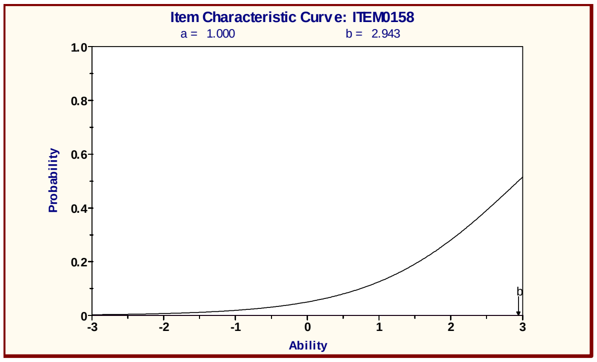


Figure 132. Item Characteristic Curve: Item 0159

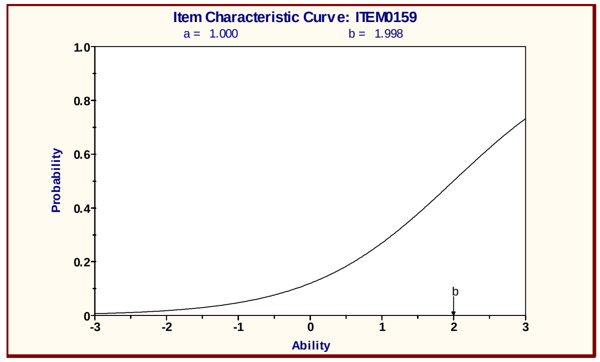


Figure 133. Item Characteristic Curve: Item 0160

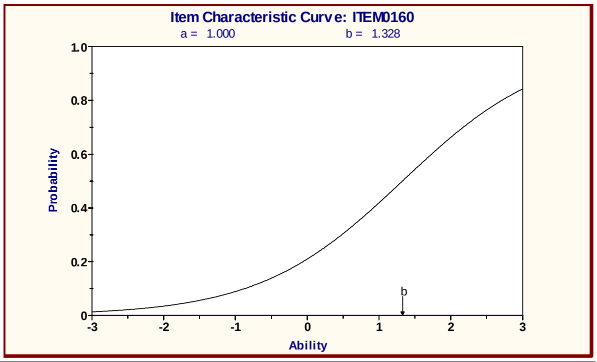


Figure 134. Item Characteristic Curve: Item 0161

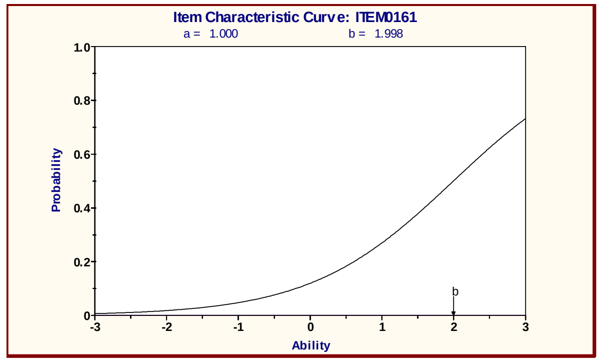


Figure 135. Item Characteristic Curve: Item 0162

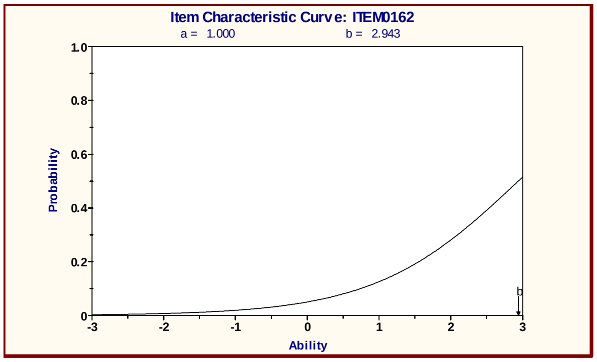


Figure 136. Item Characteristic Curve: Item 0163

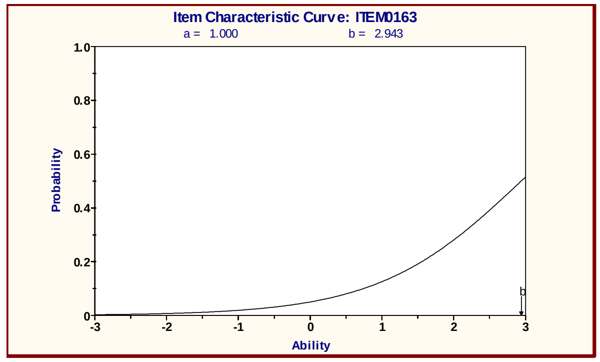


Figure 137. Item Characteristic Curve: Item 0164

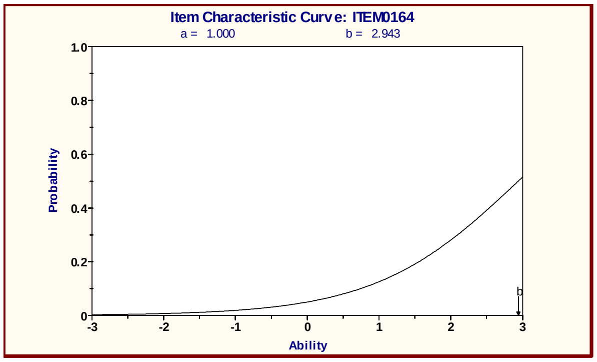


Figure 138. Item Characteristic Curve: Item 0165

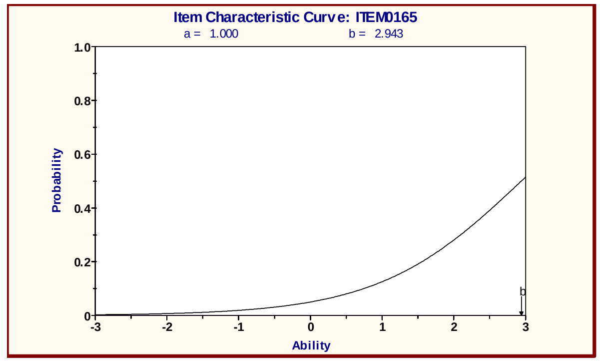
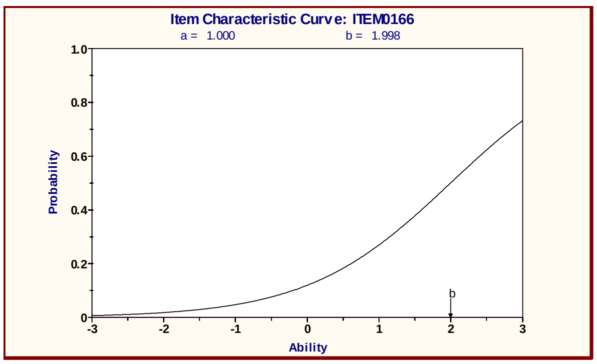


Figure 139. Item Characteristic Curve: Item 0165



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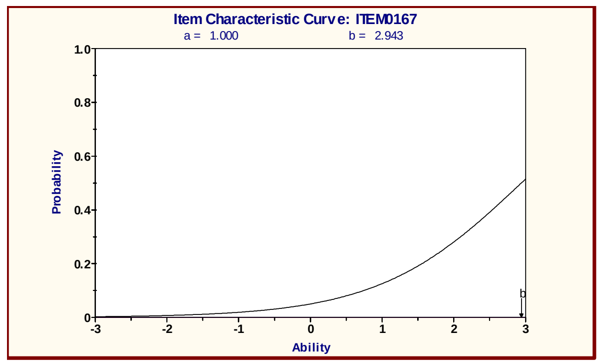


Figure 141. Item Characteristic Curve: Item 0168

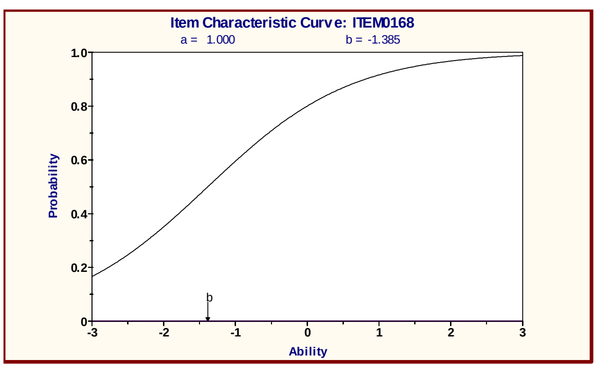


Figure 142 .Item Characteristic Curve: Item 0169

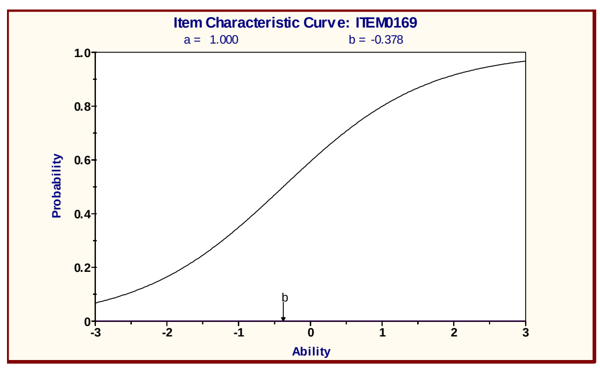


Figure 143. Item Characteristic Curve: Item 0170

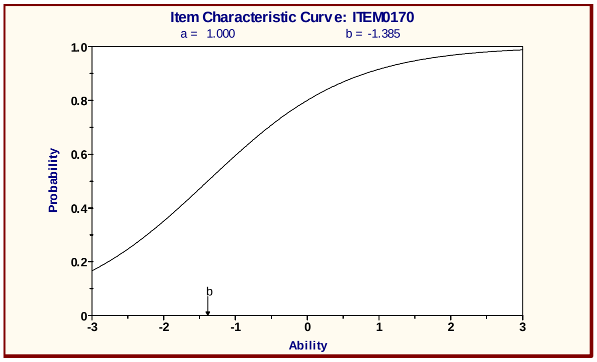


Figure 144. Item Characteristic Curve: Item 0171

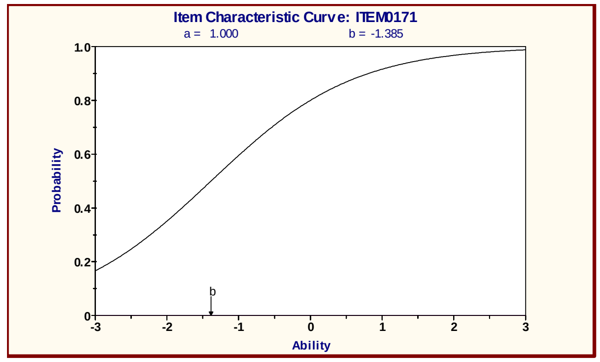


Figure 145. Item Characteristic Curve: Item 0172

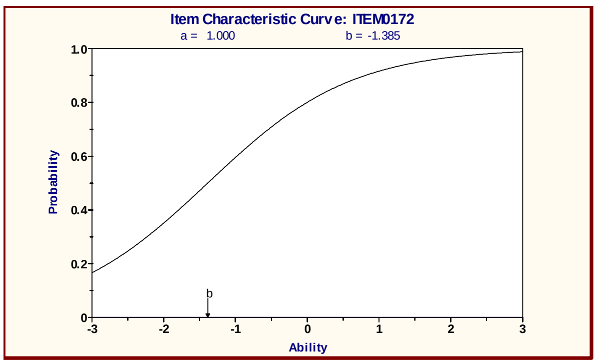


Figure 146. Item Characteristic Curve: Item 0174

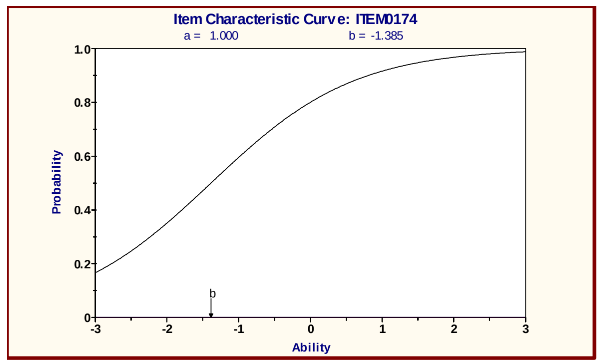


Figure 147. Item Characteristic Curve: Item 0175

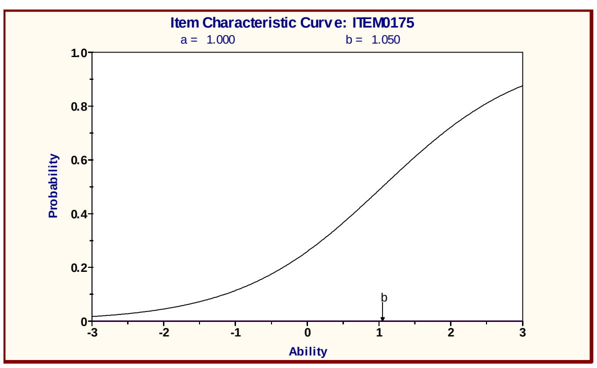


Figure 148. Item Characteristic Curve: Item 0176

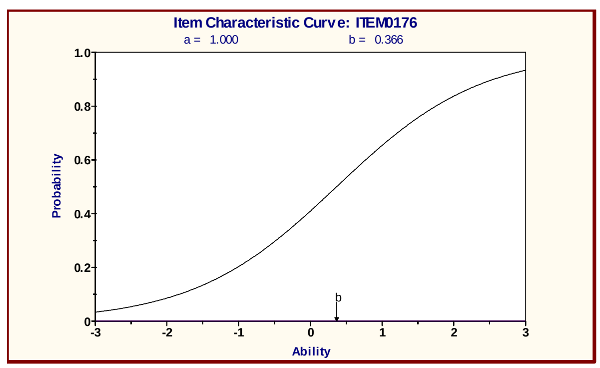


Figure 149. Item Characteristic Curve: Item 0177

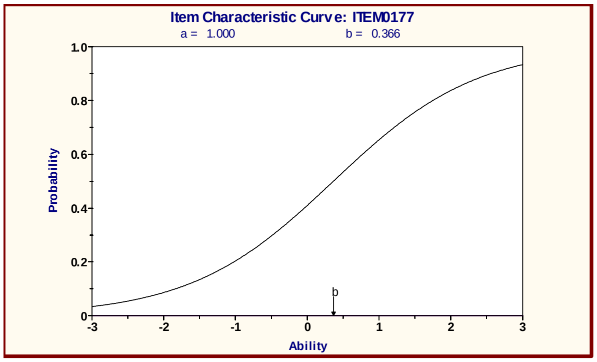


Figure 150. Item Characteristic Curve: Item 0178

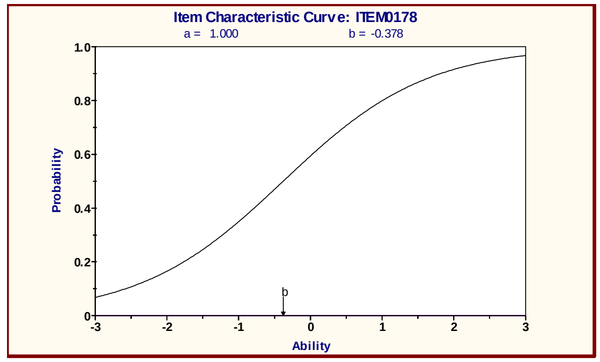


Figure 151. Item Characteristic Curve: Item 0179

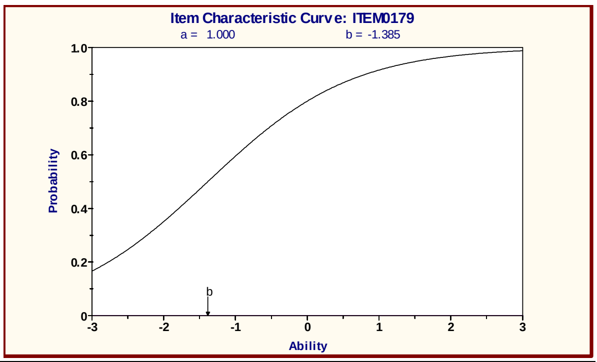


Figure 152. Item Characteristic Curve: Item 0180

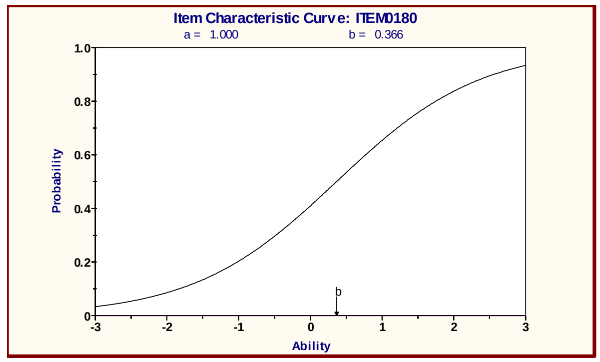


Figure 153. Item Characteristic Curve: Item 0181

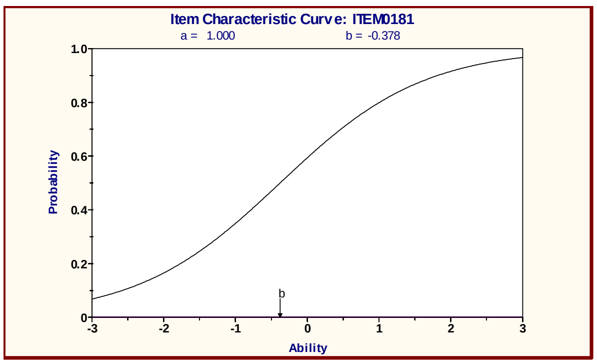


Figure 154. Item Characteristic Curve: Item 0182

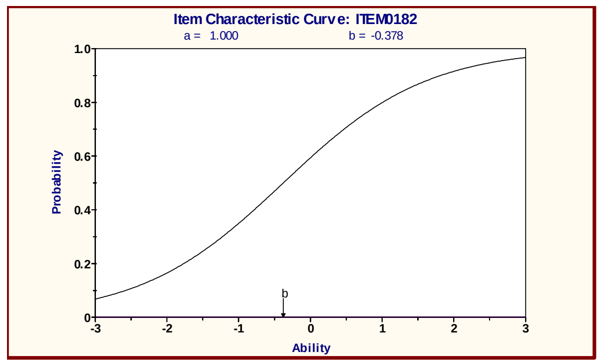


Figure 155. Item Characteristic Curve: Item 0183

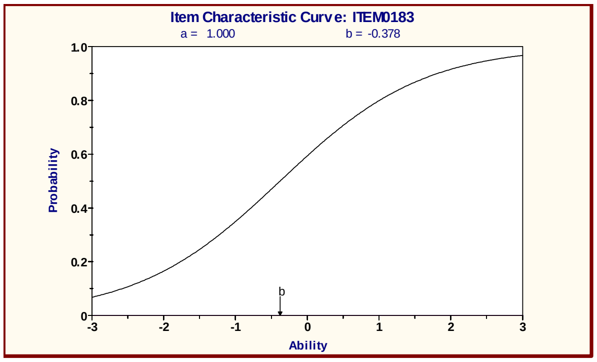


Figure 156. Item Characteristic Curve: Item 0184

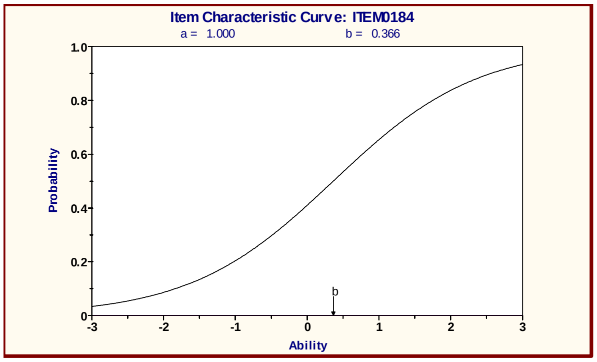


Figure 157. Item Characteristic Curve: Item 0185

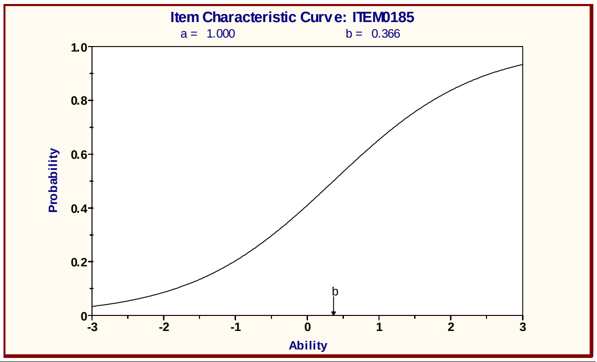


Figure 158. Item Characteristic Curve: Item 0186

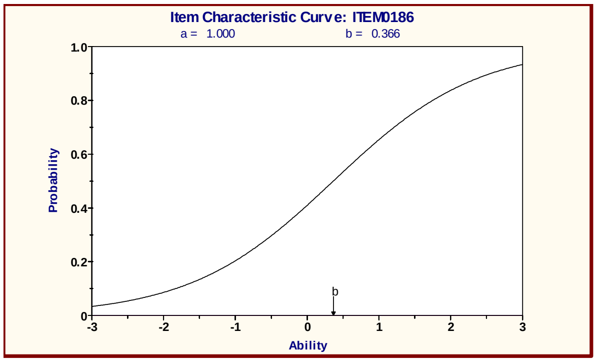


Figure 159. Item Characteristic Curve: Item 0187

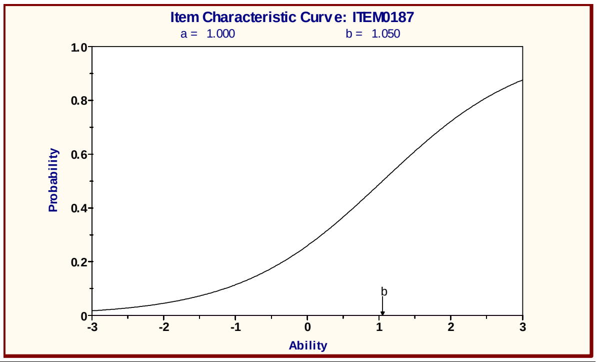


Figure 160. Item Characteristic Curve: Item 0188

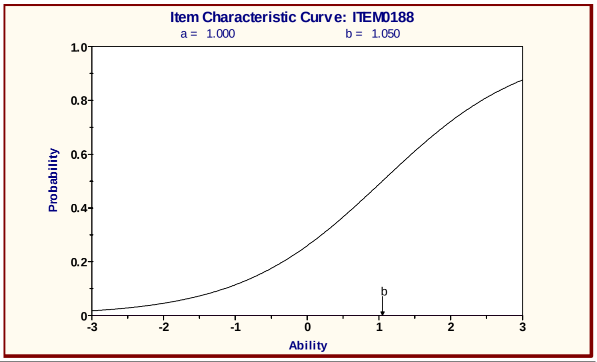


Figure 161. Item Characteristic Curve: Item 0189

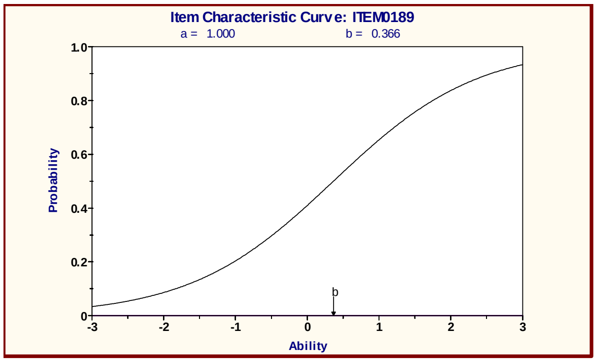


Figure 162. Item Characteristic Curve: Item 0190

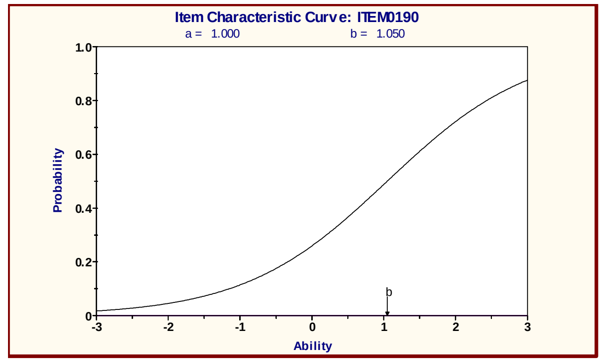


Figure 163. Item Characteristic Curve: Item 0191

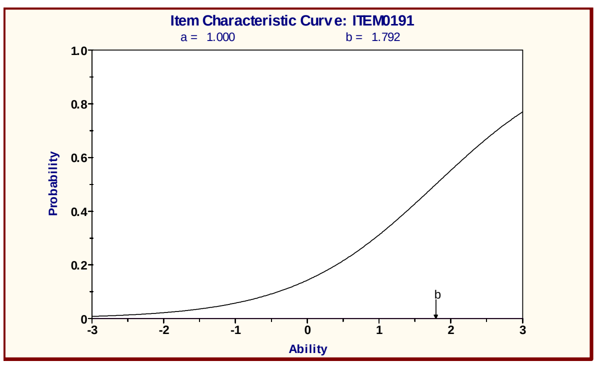


Figure 164. Item Characteristic Curve: Item 0192

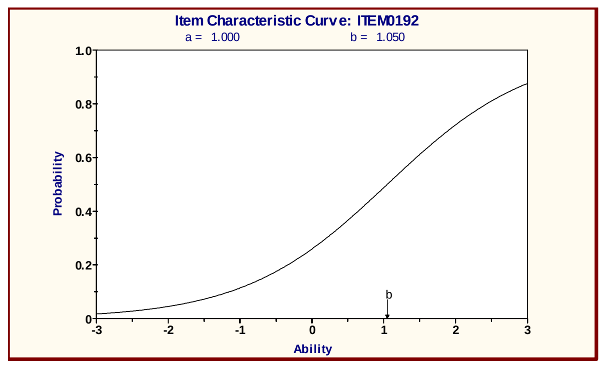


Figure 165. Item Characteristic Curve: Item 0193

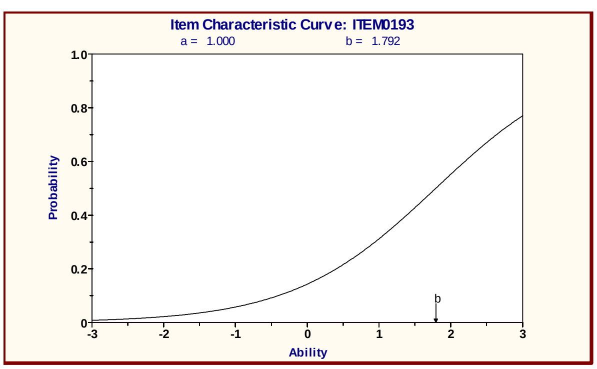


Figure 166. Item Characteristic Curve: Item 0194

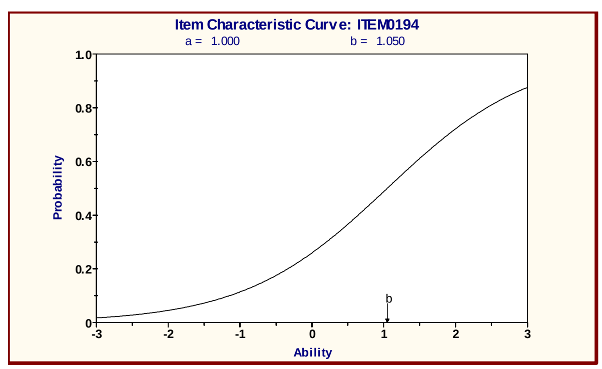


Figure 167. Item Characteristic Curve: Item 0195

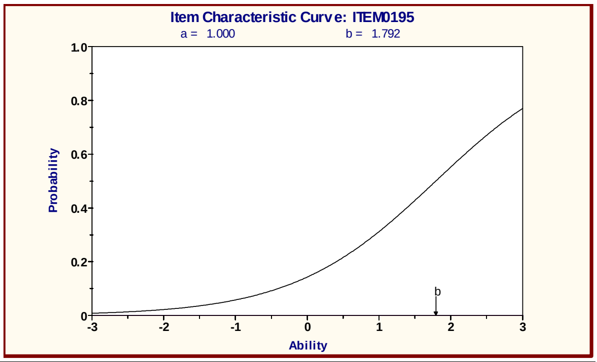


Figure 168. Item Characteristic Curve: Item 0196

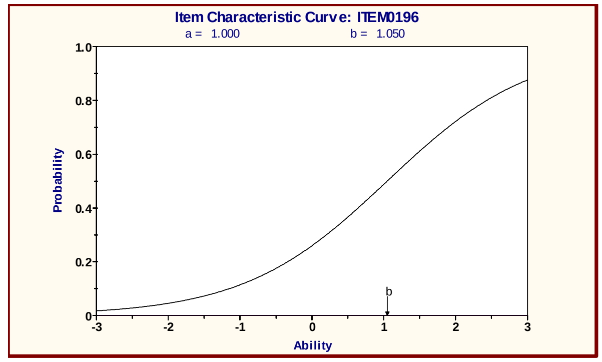


Figure 169. Item Characteristic Curve: Item 0197

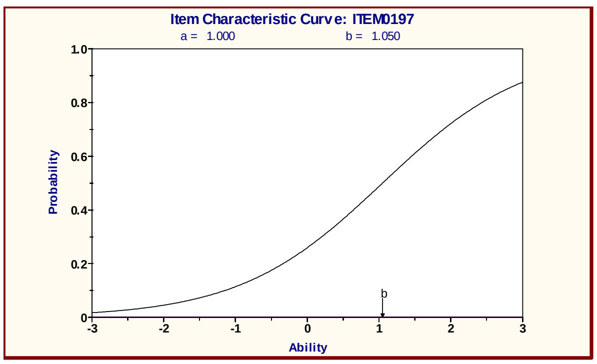


Figure 170. Item Characteristic Curve: Item 0198

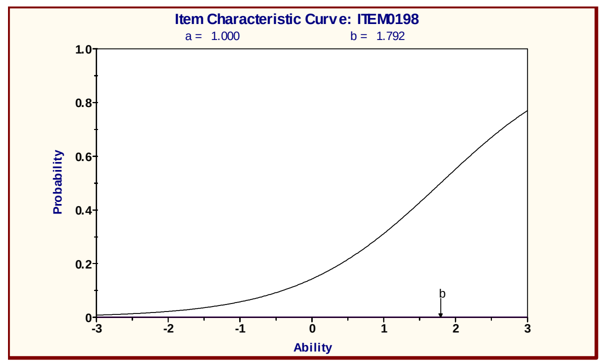


Figure 171. Item Characteristic Curve: Item 0199

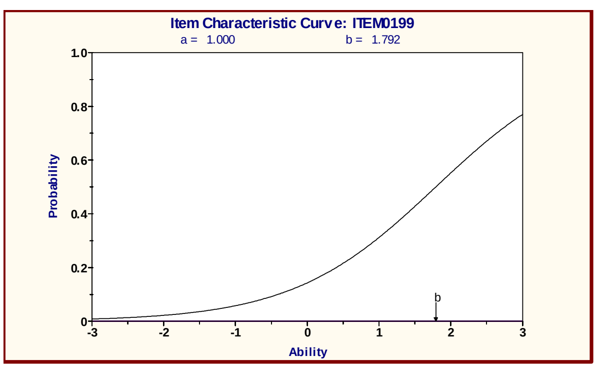


Figure 172. Item Characteristic Curve: Item 0200

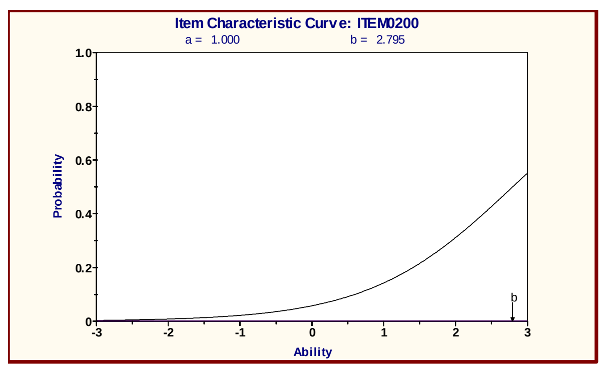


Figure 173. Item Characteristic Curve: Item 0201

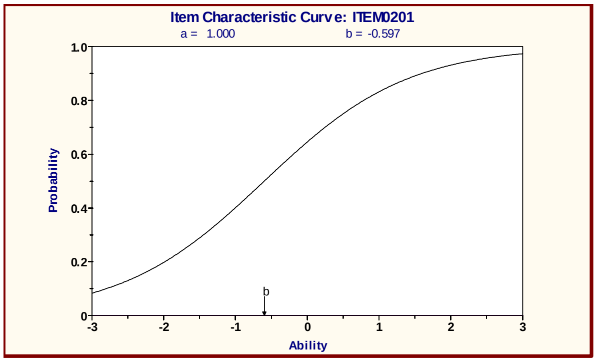


Figure 174. Item Characteristic Curve: Item 0202

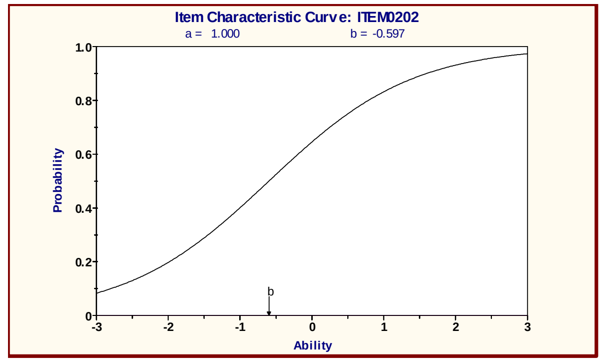


Figure 175. Item Characteristic Curve: Item 0203

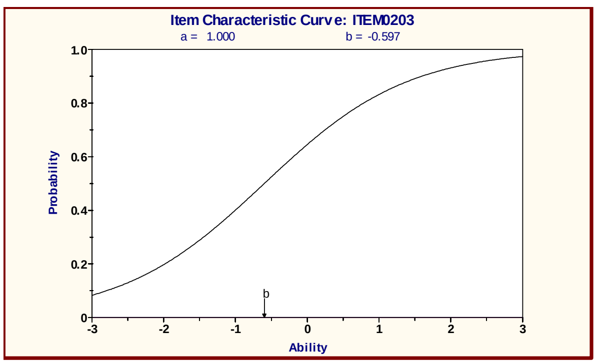


Figure 176. Item Characteristic Curve: Item 0204

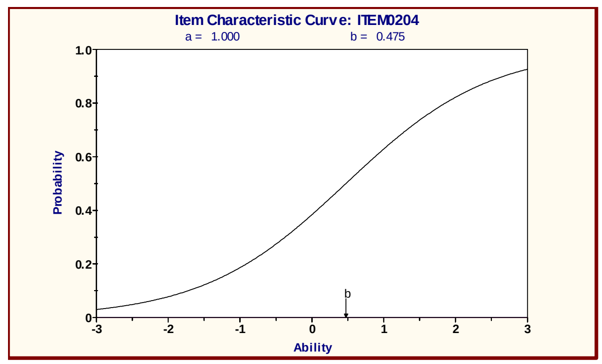


Figure 177. Item Characteristic Curve: Item 0205

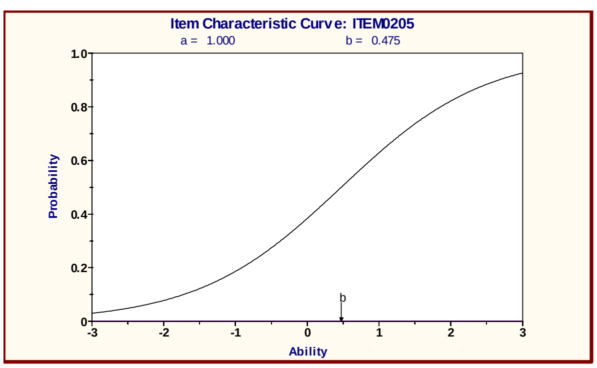


Figure 178. Item Characteristic Curve: Item 0206

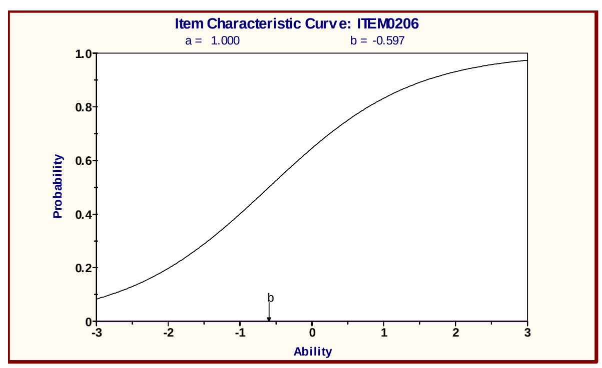


Figure 179. Item Characteristic Curve: Item 0208

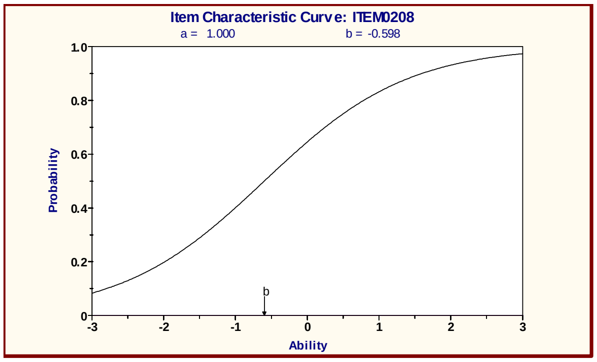


Figure 180. Item Characteristic Curve: Item 0209

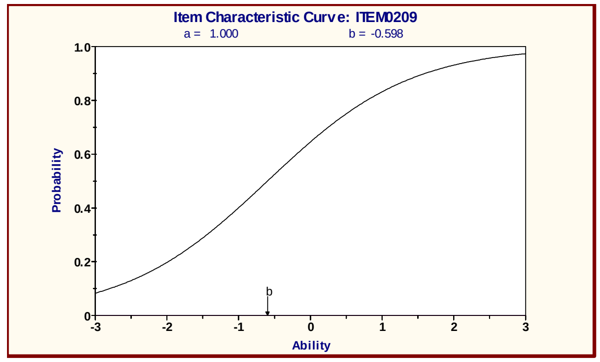


Figure 181. Item Characteristic Curve: Item 0210

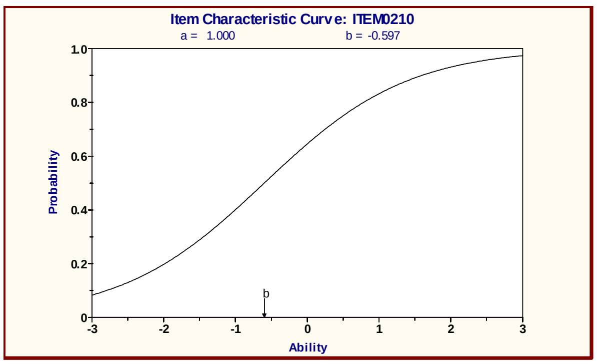


Figure 182. Item Characteristic Curve: Item 0213

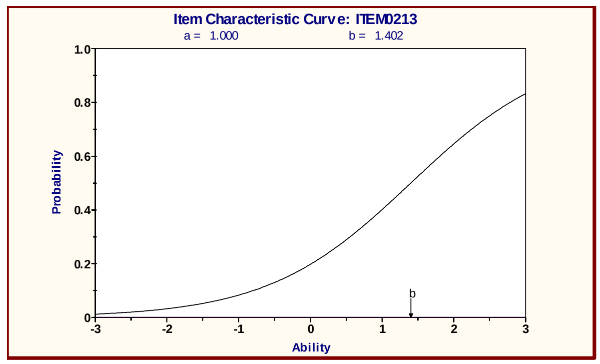


Figure 183. Item Characteristic Curve: Item 0214

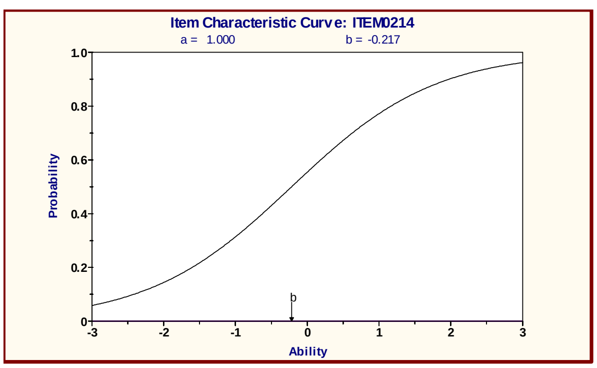


Figure 184. Item Characteristic Curve: Item 0216

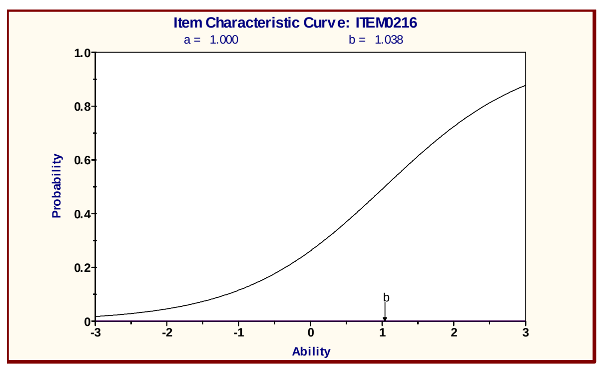


Figure 185. Item Characteristic Curve: Item 0217

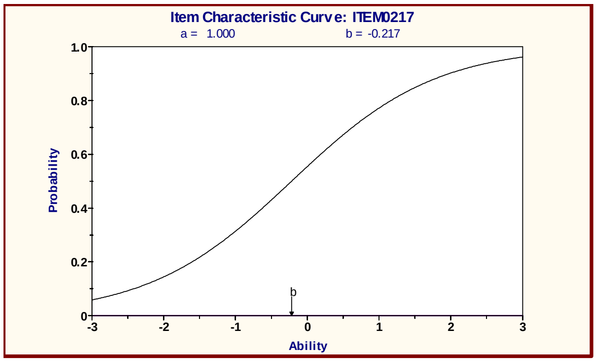


Figure 186. Item Characteristic Curve: Item 0222

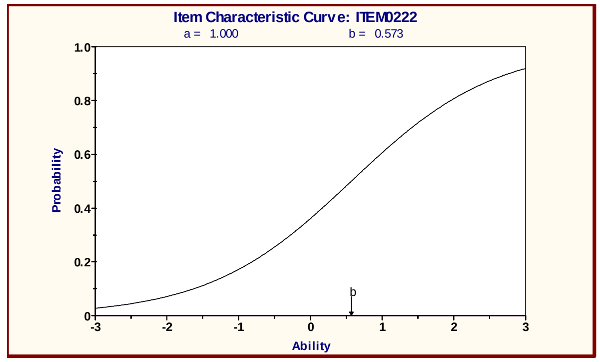


Figure 187. Item Characteristic Curve: Item 0223

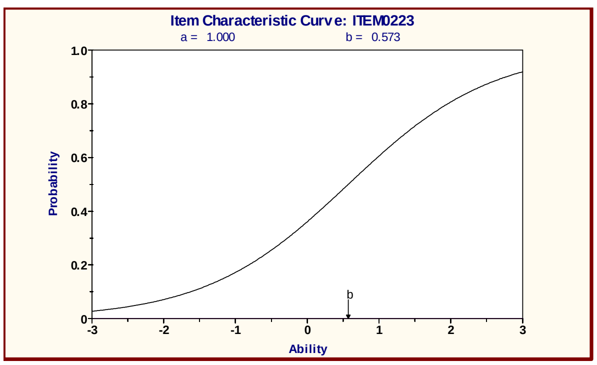


Figure 188. Item Characteristic Curve: Item 0224

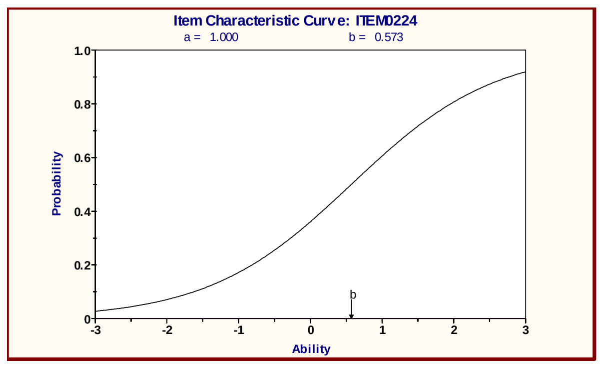


Figure 189. Item Characteristic Curve: Item 0226

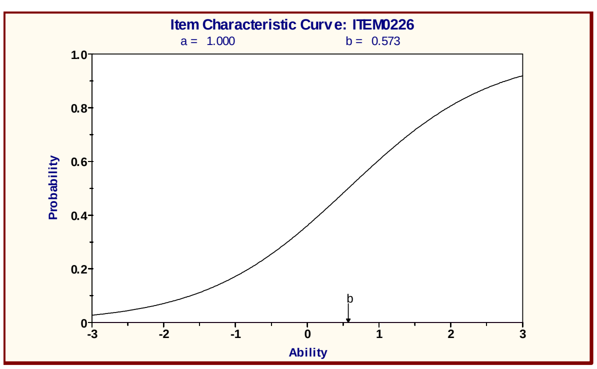


Figure 190. Item Characteristic Curve: Item 0227

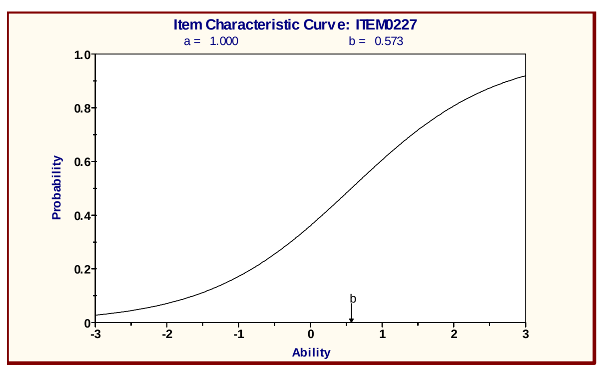


Figure 191. Item Characteristic Curve: Item 0228

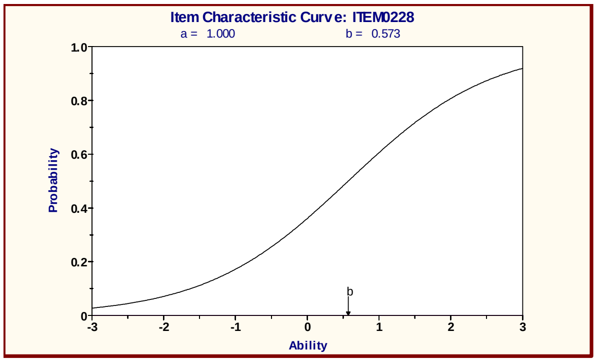


Figure 192. Item Characteristic Curve: Item 0230

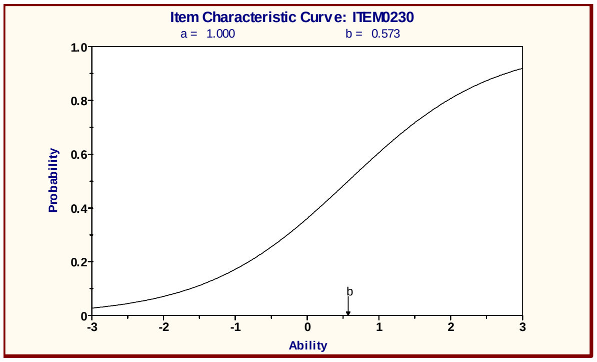


Figure 193. Item Characteristic Curve: Item 0231

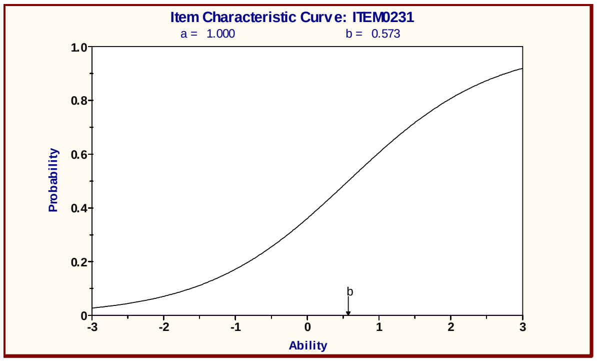


Figure 194. Item Characteristic Curve: Item 0232

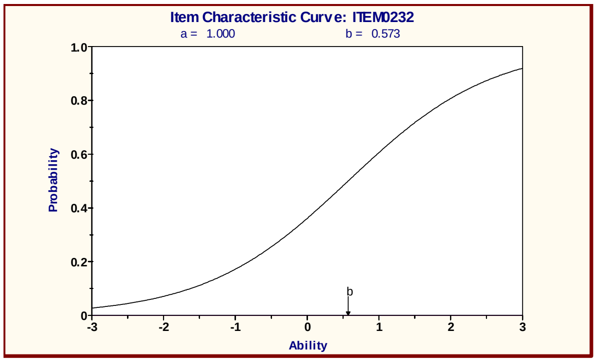


Figure 195. Item Characteristic Curve: Item 0234

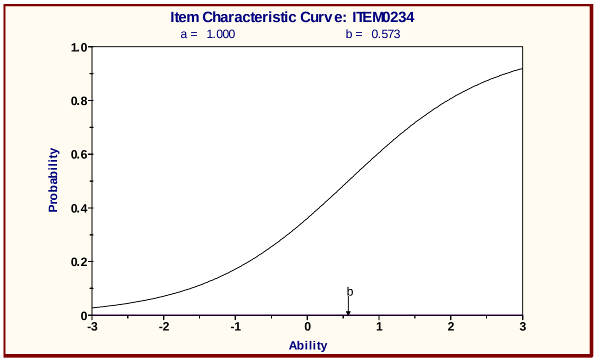


Figure 196. Item Characteristic Curve: Item 0237

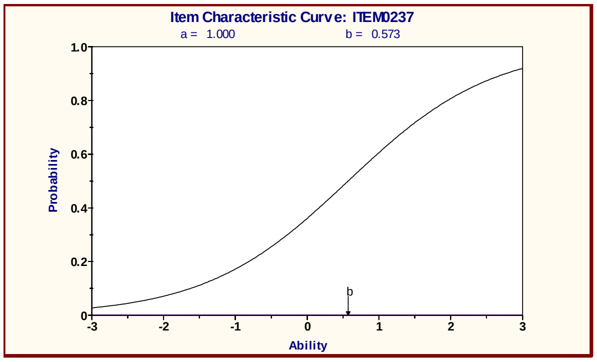


Figure 197. Item Characteristic Curve: Item 0243

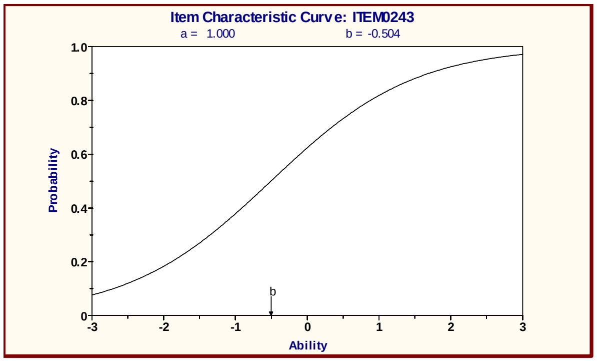


Figure 198. Item Characteristic Curve: Item 0244

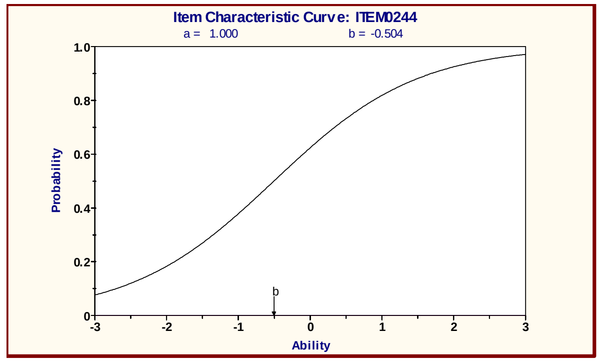


Figure 199. Item Characteristic Curve: Item 0245

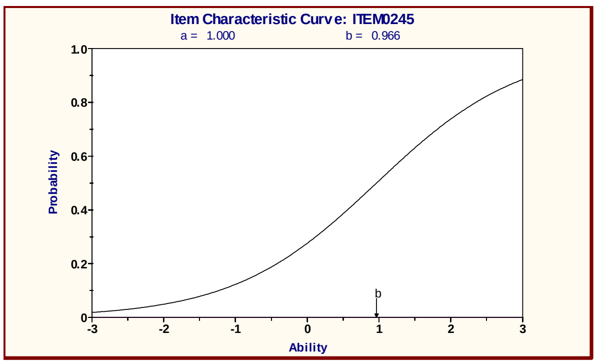


Figure 200. Item Characteristic Curve: Item 0246

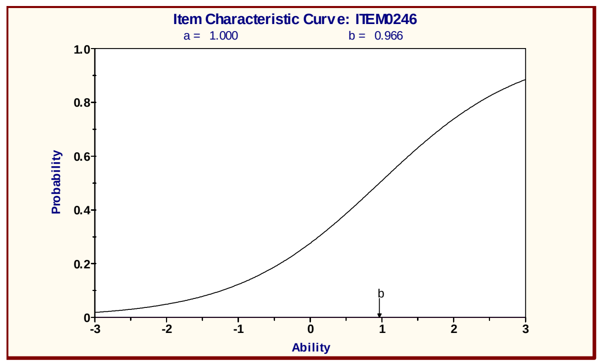


Figure 201. Item Characteristic Curve: Item 0247

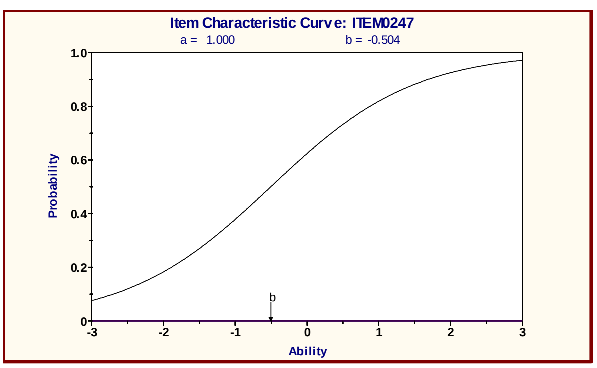


Figure 202. Item Characteristic Curve: Item 0248

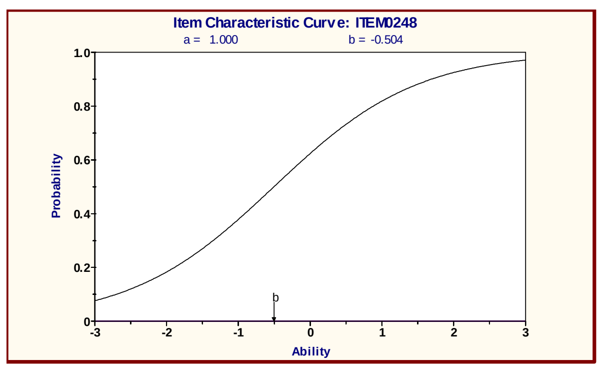


Figure 203. Item Characteristic Curve: Item 0250

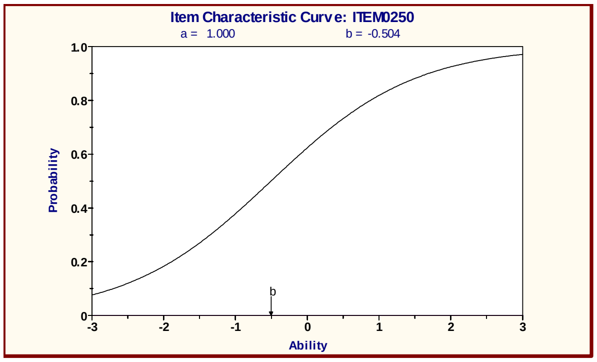


Figure 204. Item Characteristic Curve: Item 0256

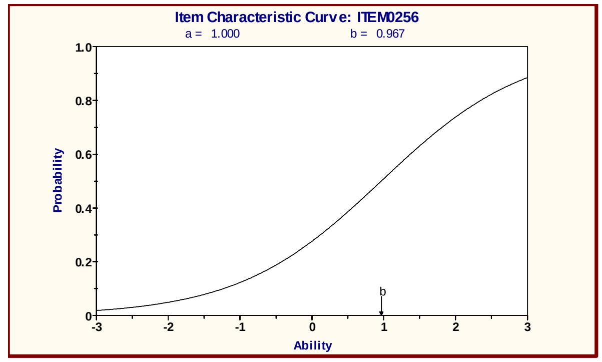


Figure 205. Item Characteristic Curve: Item 0257

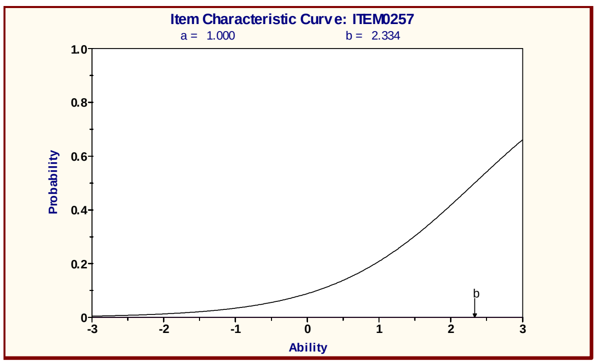


Figure 206. Item Characteristic Curve: Item 0258

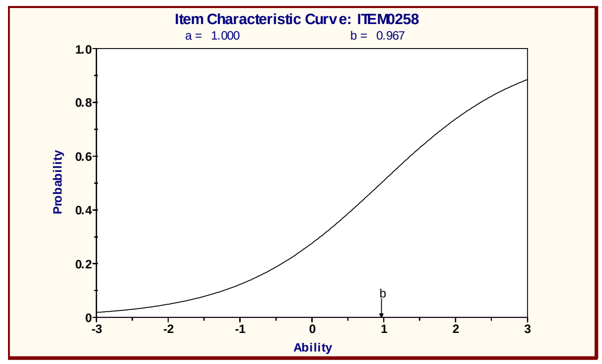


Figure 207. Item Characteristic Curve: Item 0259

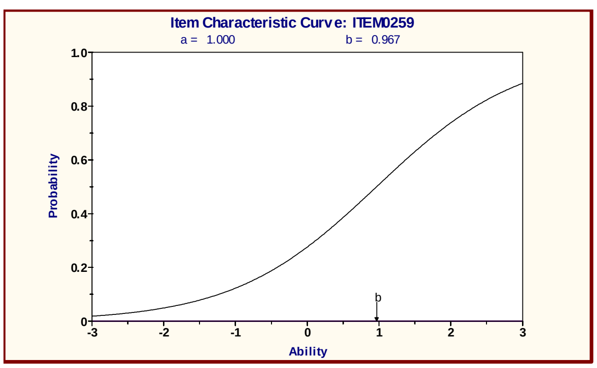


Figure 208. Item Characteristic Curve: Item 0260

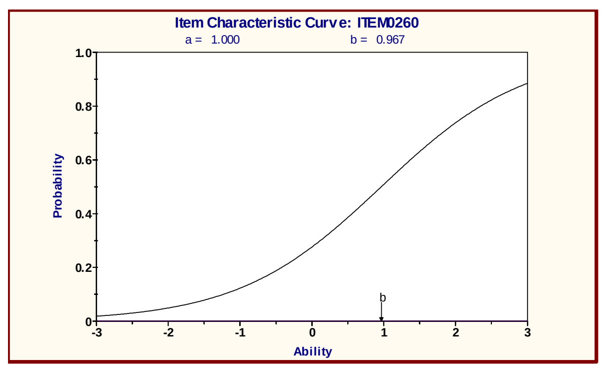


Figure 209. Item Characteristic Curve: Item 0261

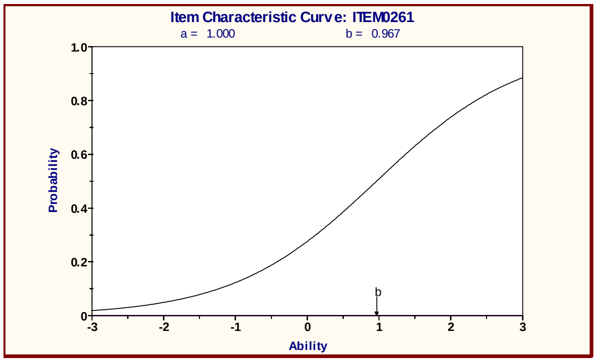


Figure 210. Item Characteristic Curve: Item 0262

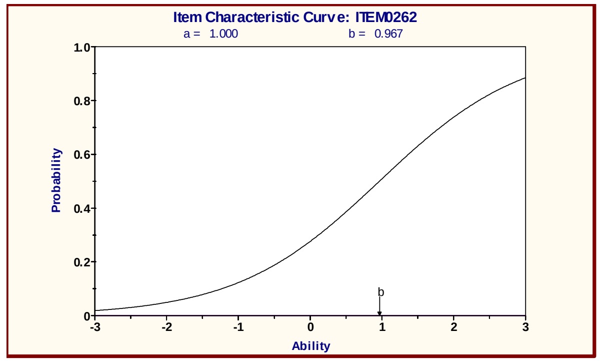


Figure 211. Item Characteristic Curve: Item 0263

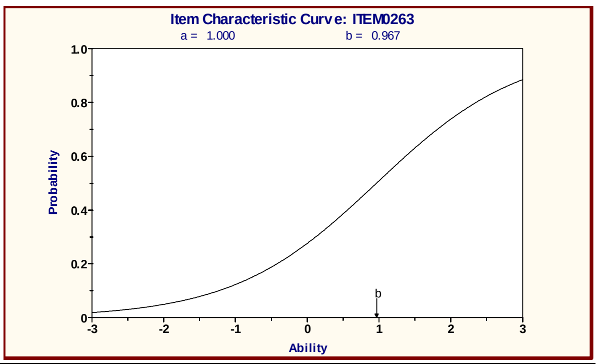


Figure 212. Item Characteristic Curve: Item 0264

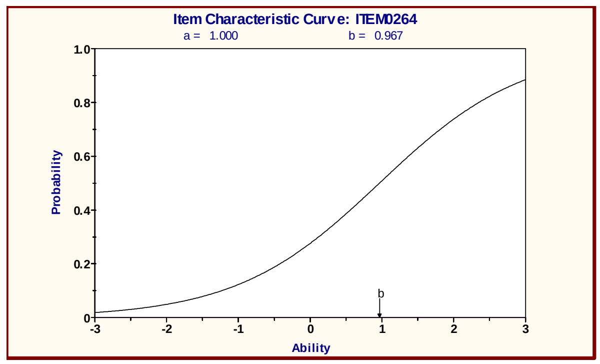


Figure 213. Item Characteristic Curve: Item 0266

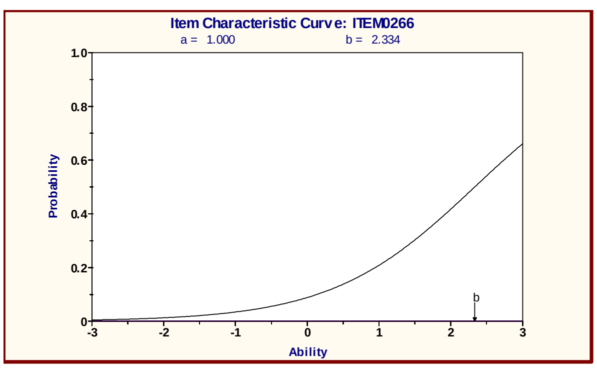


Figure 214. Item Characteristic Curve: Item 0267

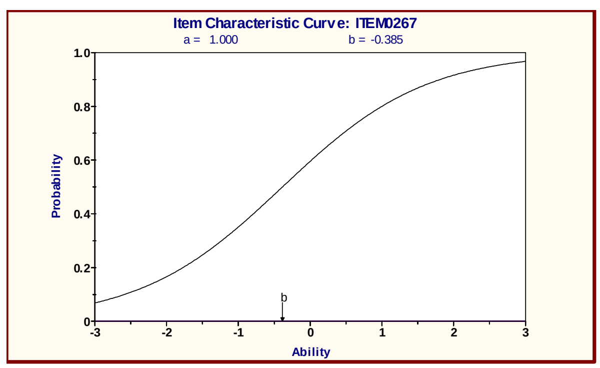


Figure 215. Item Characteristic Curve: Item 0269

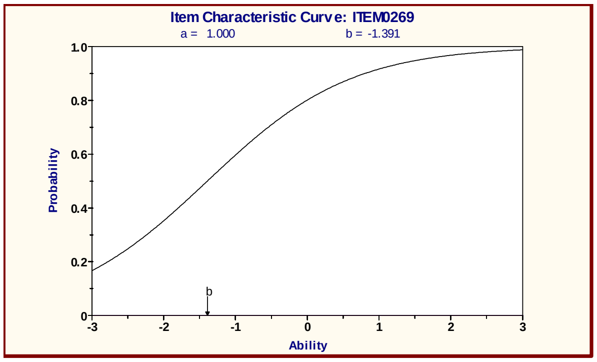


Figure 216. Item Characteristic Curve: Item 0271

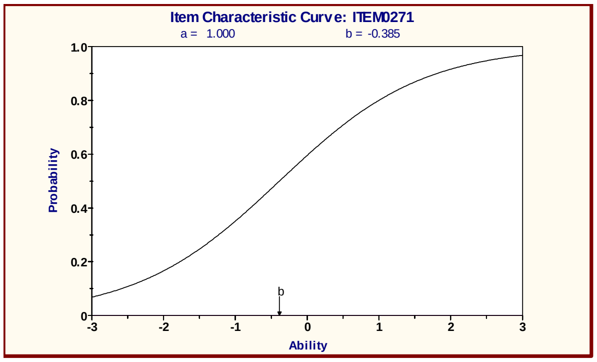


Figure 217. Item Characteristic Curve: Item 0273

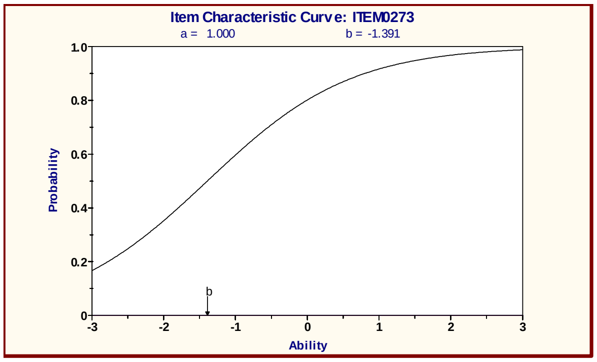


Figure 218. Item Characteristic Curve: Item 0275

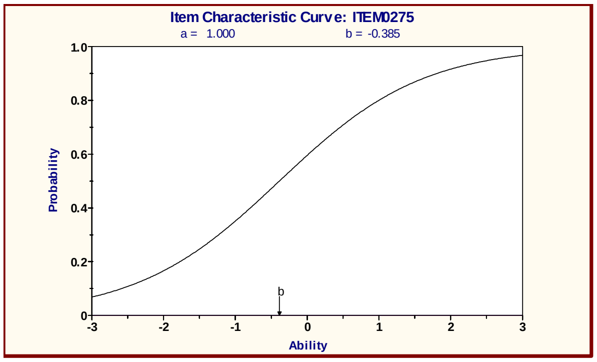


Figure 219. Item Characteristic Curve: Item 0276

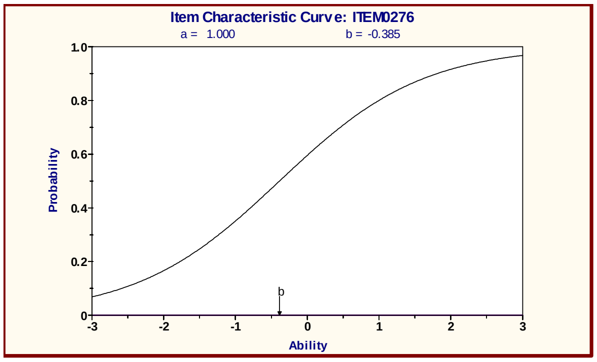


Figure 220. Item Characteristic Curve: Item 0277

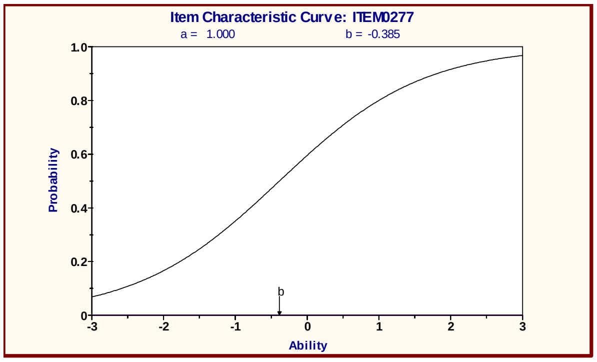


Figure 221. Item Characteristic Curve: Item 0278

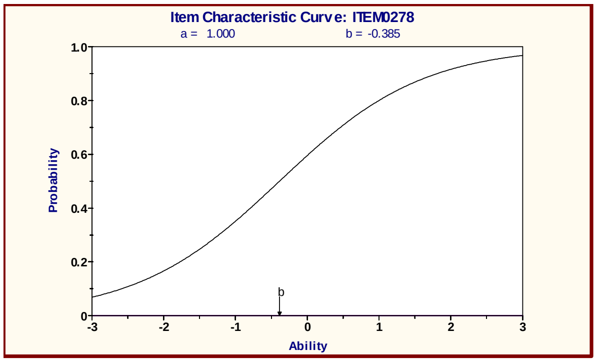


Figure 222. Item Characteristic Curve: Item 0279

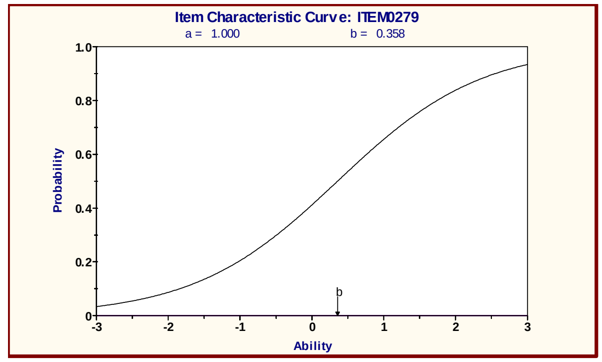


Figure 223. Item Characteristic Curve: Item 0280

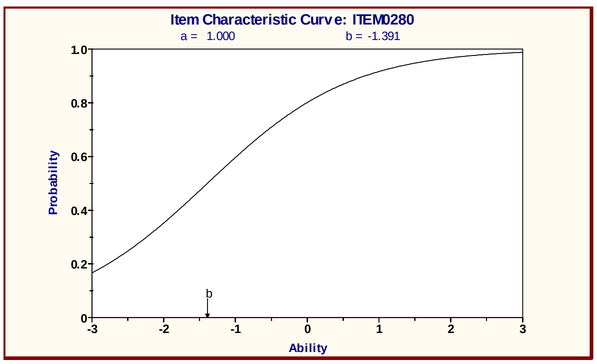


Figure 224. Item Characteristic Curve: Item 0281

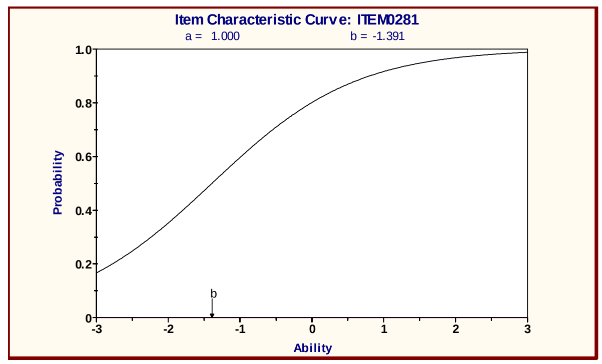


Figure 225. Item Characteristic Curve: Item 0282

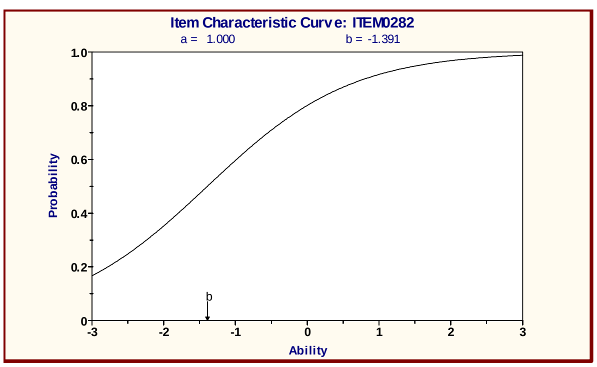


Figure 226. Item Characteristic Curve: Item 0283

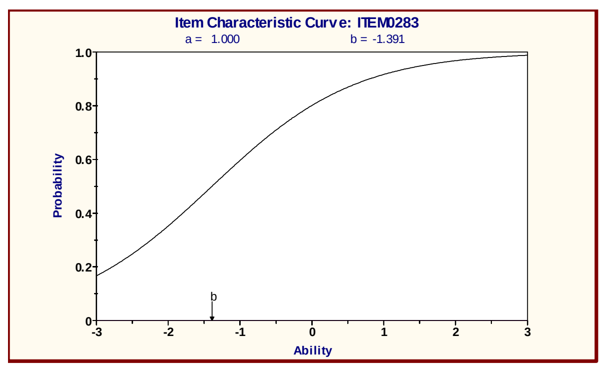


Figure 227. Item Characteristic Curve: Item 0284

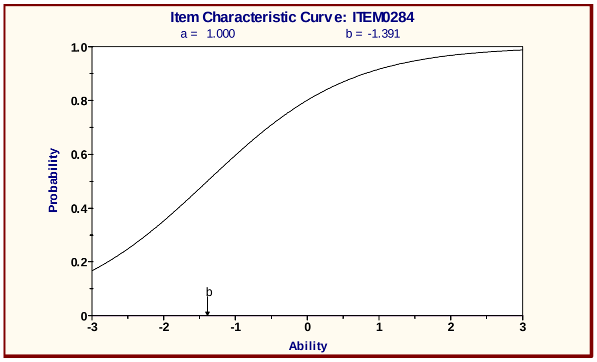


Figure 228. Item Characteristic Curve: Item 0285

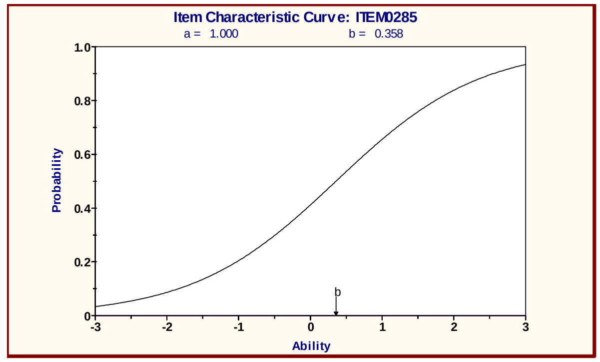


Figure 229. Item Characteristic Curve: Item 0286

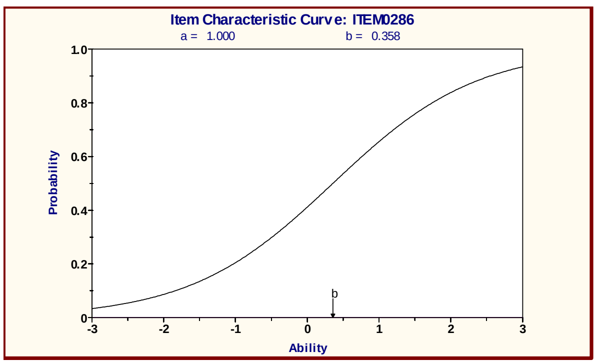


Figure 230. Item Characteristic Curve: Item 0287

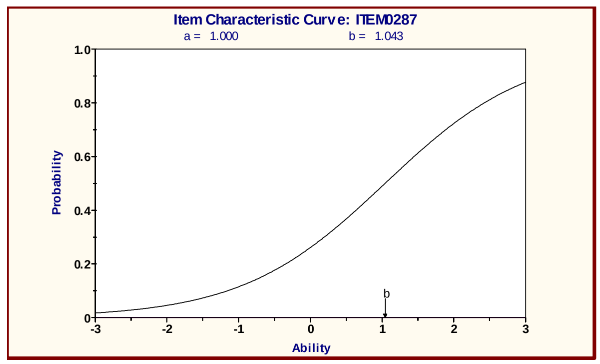


Figure 231. Item Characteristic Curve: Item 0288

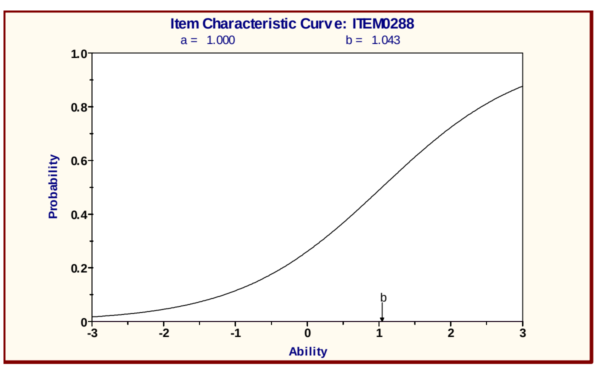


Figure 232. Item Characteristic Curve: Item 0289

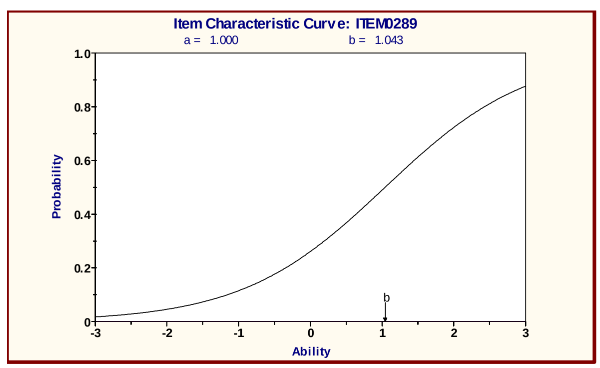


Figure 233. Item Characteristic Curve: Item 0290

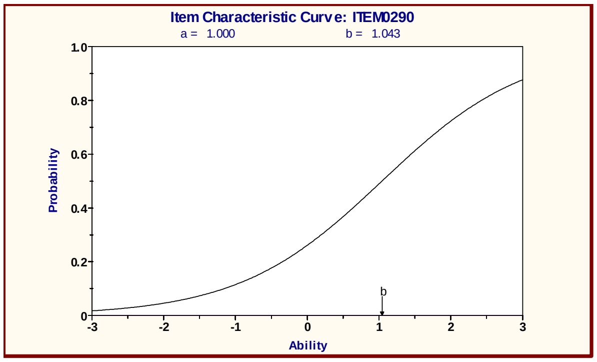


Figure 234. Item Characteristic Curve: Item 0294

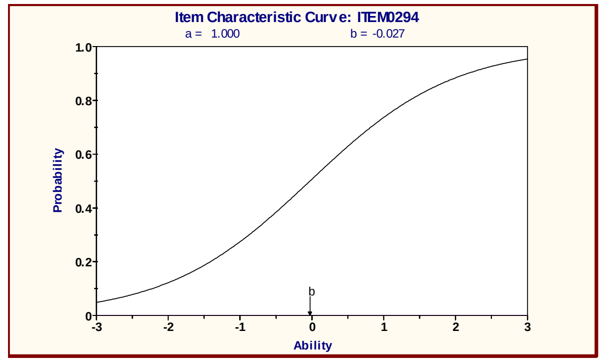


Figure 235. Item Characteristic Curve: Item 0299

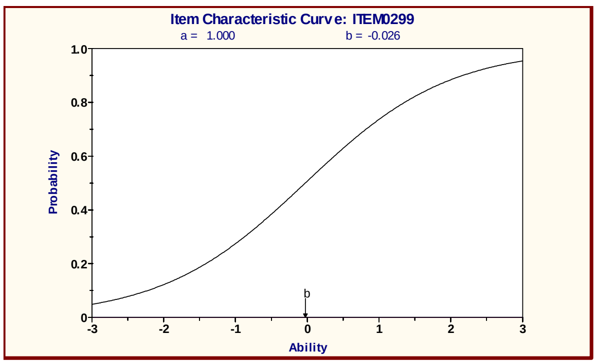


Figure 236. Item Characteristic Curve: Item 0303

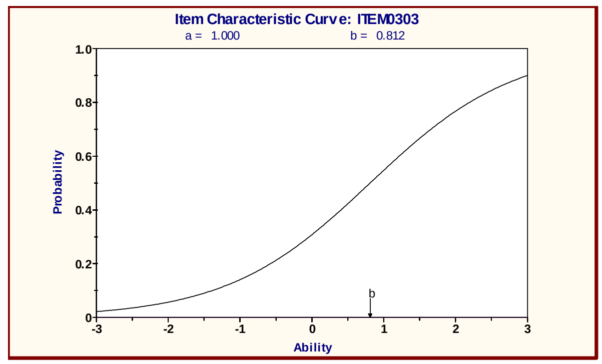


Figure 237. Item Characteristic Curve: Item 0306

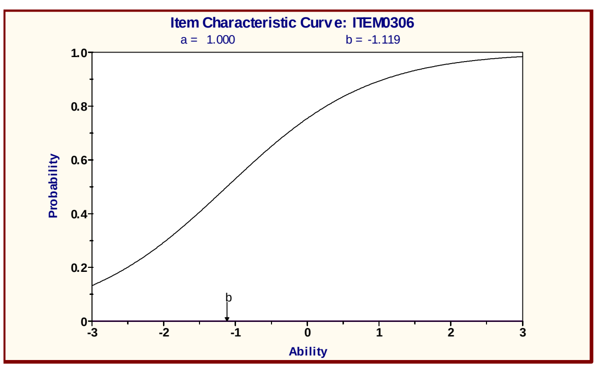


Figure 238. Item Characteristic Curve: Item 0307

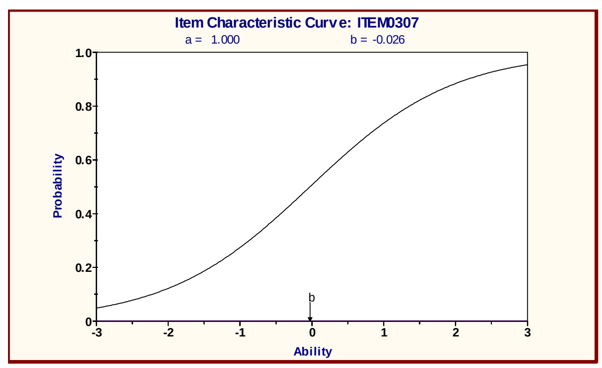


Figure 239. Item Characteristic Curve: Item 0308

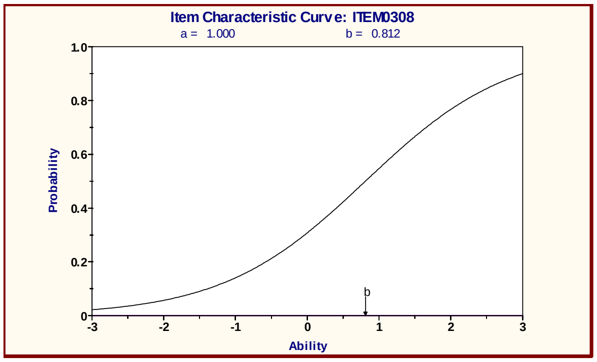


Figure 240. Item Characteristic Curve: Item 0309

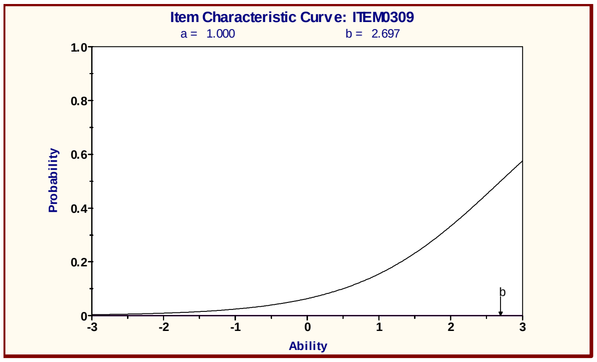


Figure 241. Item Characteristic Curve: Item 0310

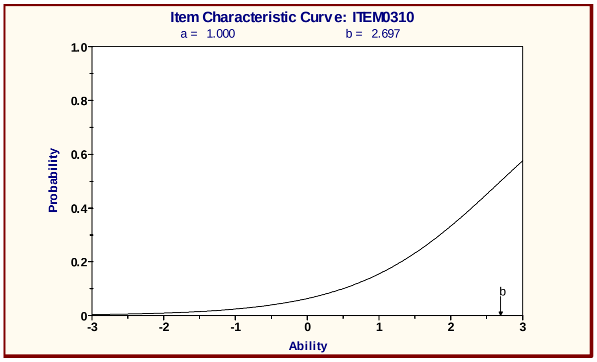


Figure 242. Item Characteristic Curve: Item 0311

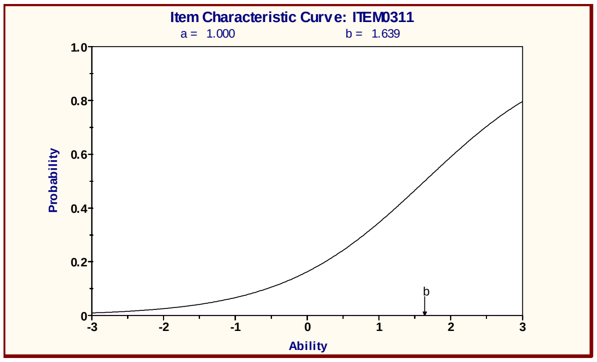


Figure 243. Item Characteristic Curve: Item 0312

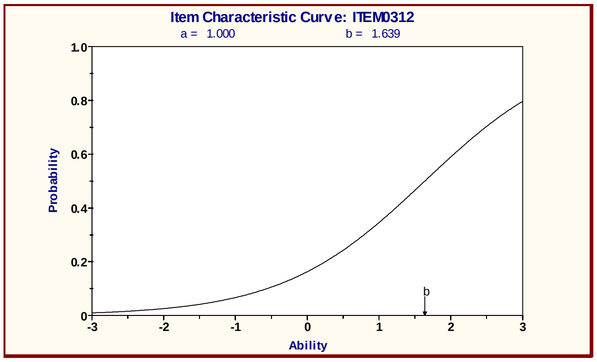


Figure 244. Item Characteristic Curve: Item 0313

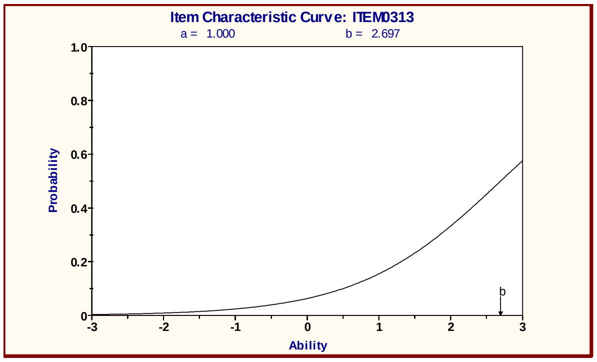


Figure 245. Item Characteristic Curve: Item 0314

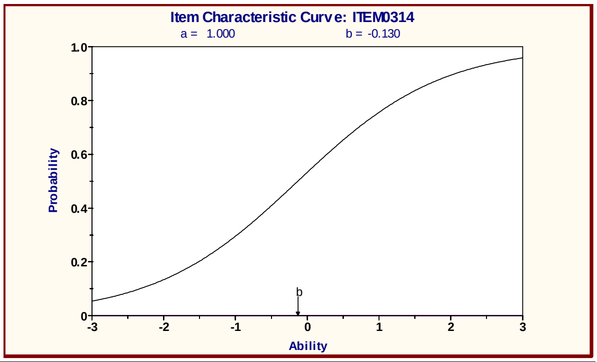


Figure 246. Item Characteristic Curve: Item 0315

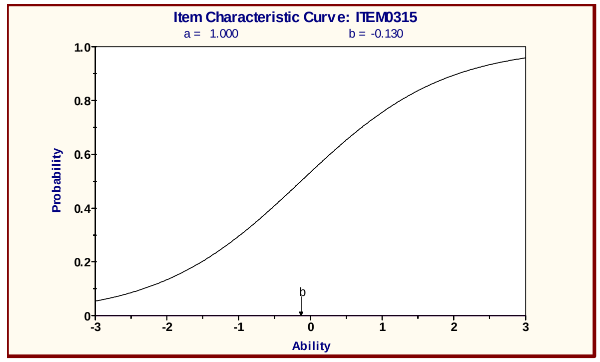


Figure 247. Item Characteristic Curve: Item 0316

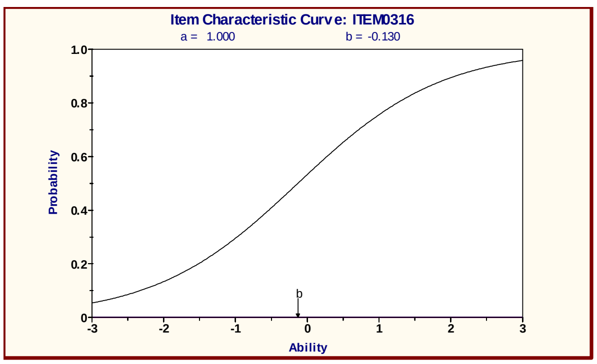


Figure 248. Item Characteristic Curve: Item 0317

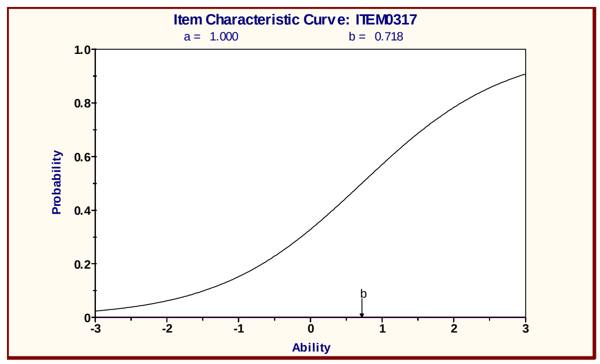


Figure 249. Item Characteristic Curve: Item 0318

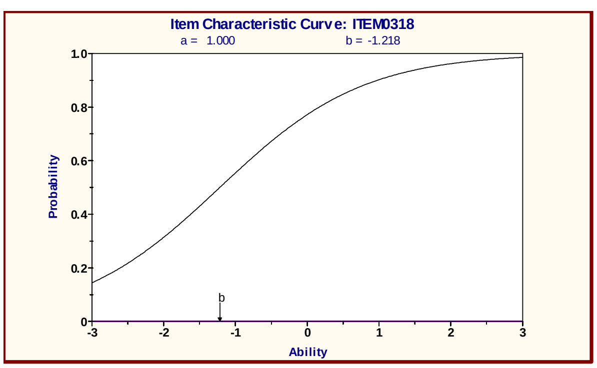


Figure 250. Item Characteristic Curve: Item 0319

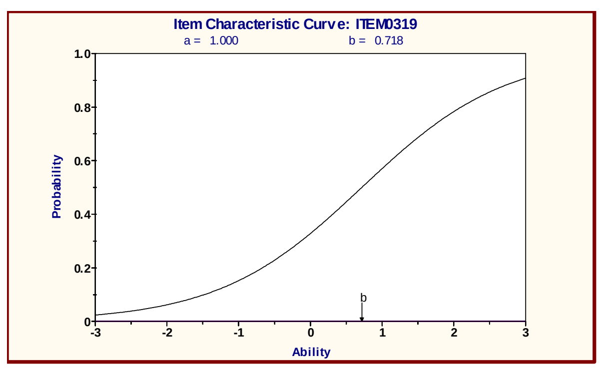


Figure 251. Item Characteristic Curve: Item 0320

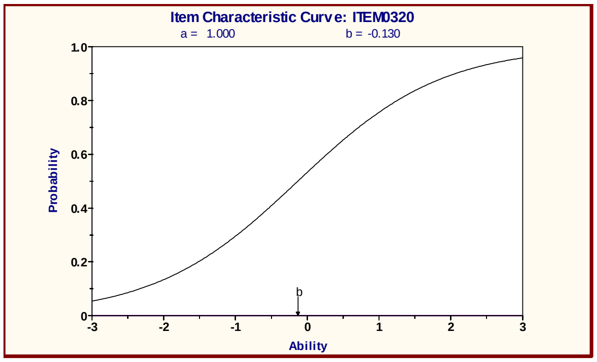


Figure 252. Item Characteristic Curve: Item 0321

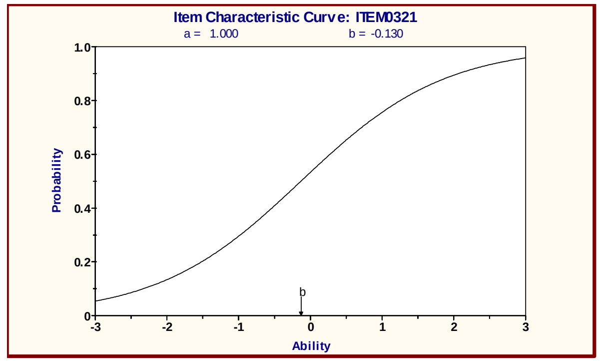


Figure 253. Item Characteristic Curve: Item 0323

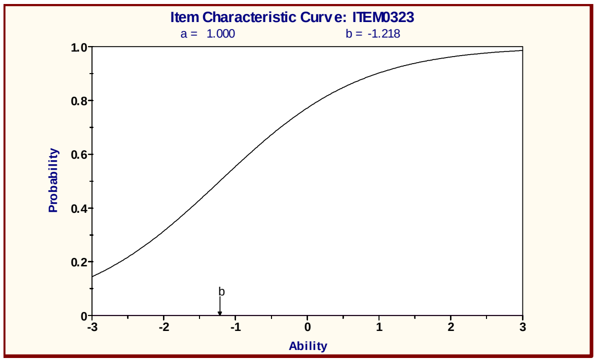


Figure 254. Item Characteristic Curve: Item 0324

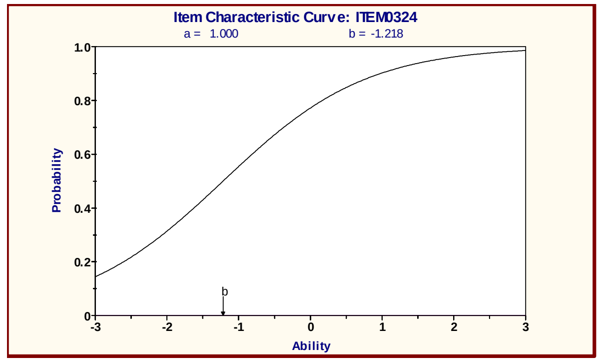


Figure 255. Item Characteristic Curve: Item 0325

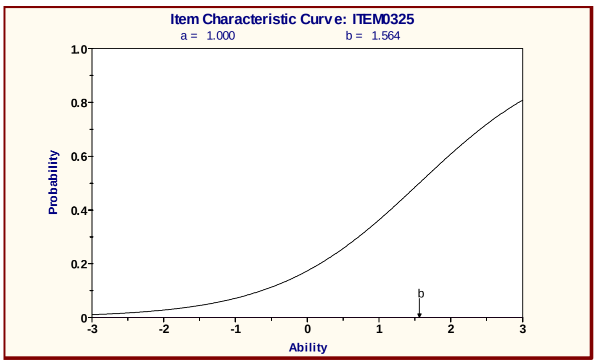


Figure 256. Item Characteristic Curve: Item 0326

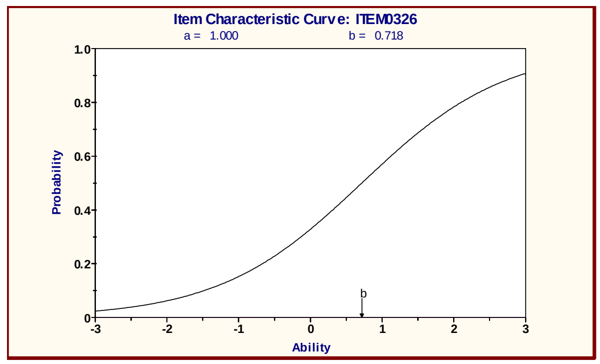


Figure 257. Item Characteristic Curve: Item 0327

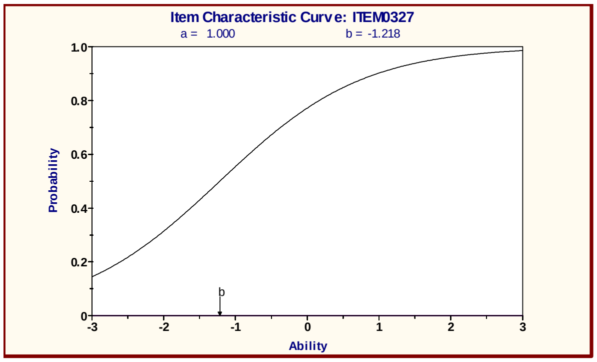


Figure 258. Item Characteristic Curve: Item 0328

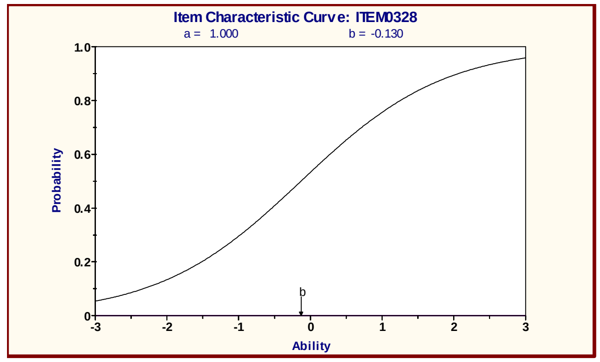


Figure 259. Item Characteristic Curve: Item 0329

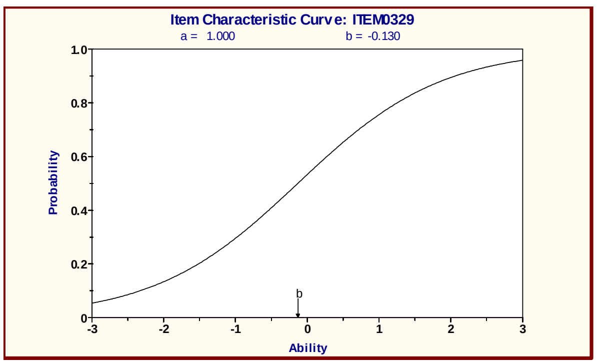


Figure 260. Item Characteristic Curve: Item 0330

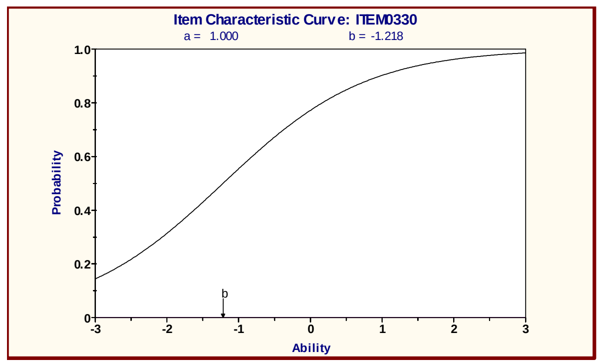


Figure 261. Item Characteristic Curve: Item 0331

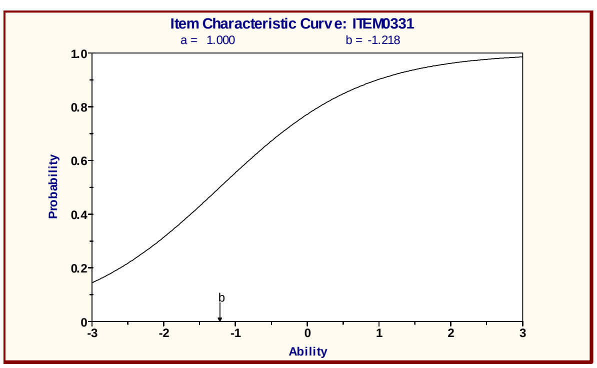


Figure 262. Item Characteristic Curve: Item 0332

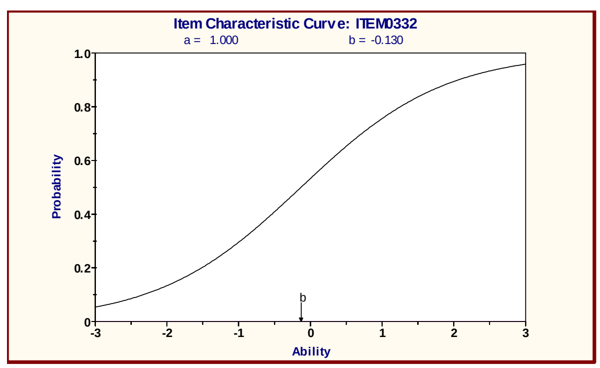


Figure 263. Item Characteristic Curve: Item 0333

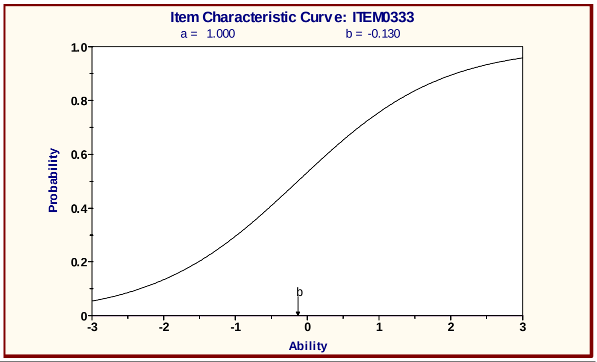


Figure 264. Item Characteristic Curve: Item 0334

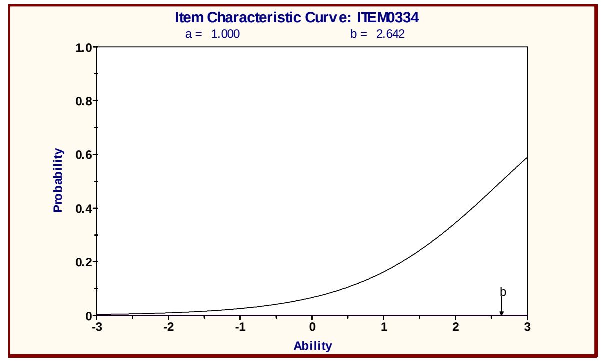


Figure 265. Item Characteristic Curve: Item 0347

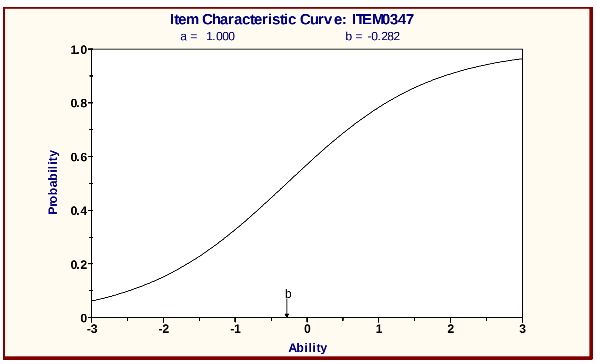


Figure 266. Item Characteristic Curve: Item 0348

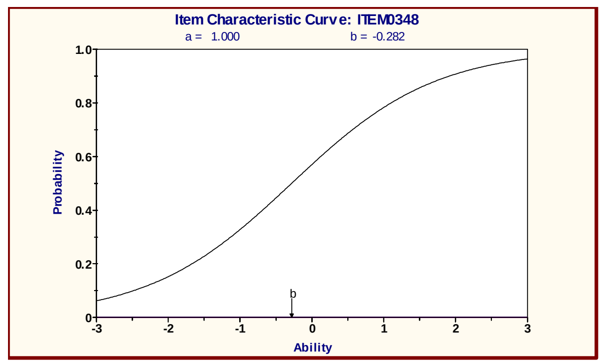


Figure 267. Item Characteristic Curve: Item 0352

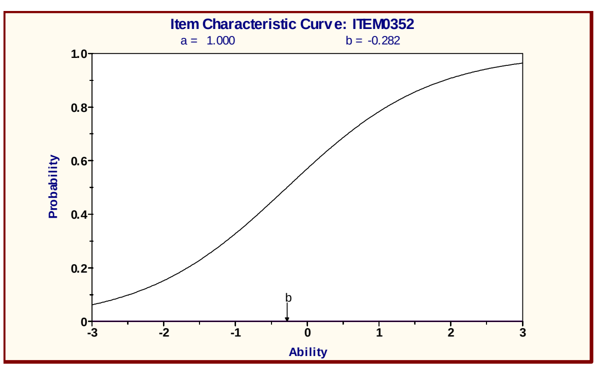


Figure 268. Item Characteristic Curve: Item 0355

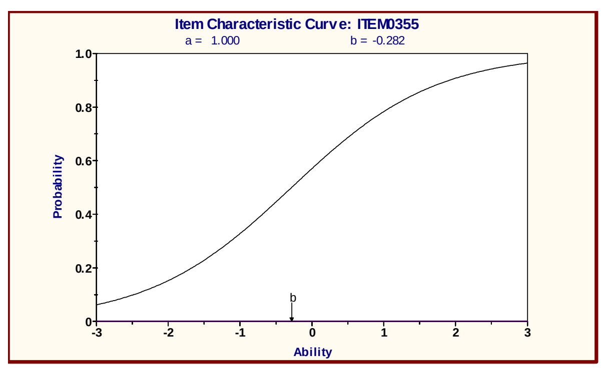


Figure 269. Item Characteristic Curve: Item 0356

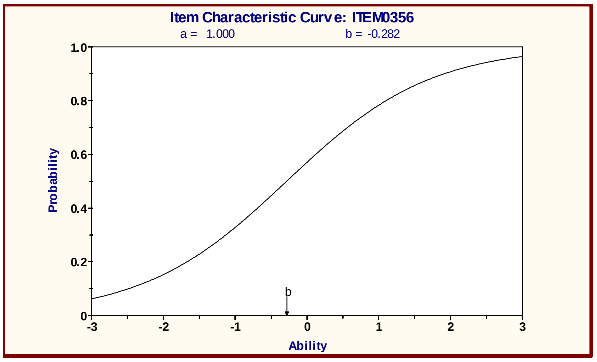


Figure 270. Item Characteristic Curve: Item 0357

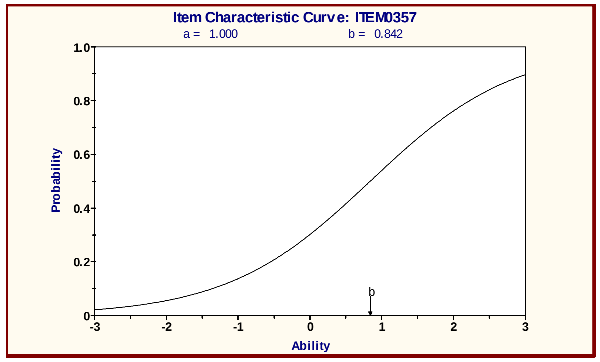


Figure 271. Item Characteristic Curve: Item 0358

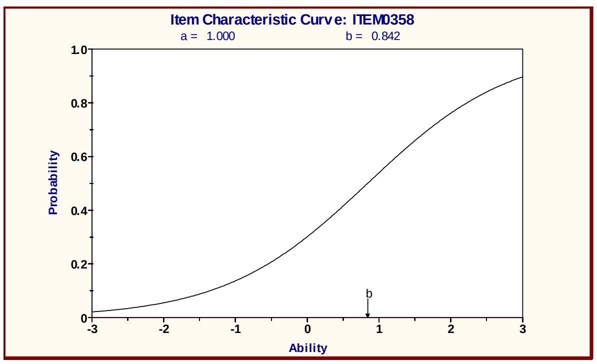


Figure 272. Item Characteristic Curve: Item 0359

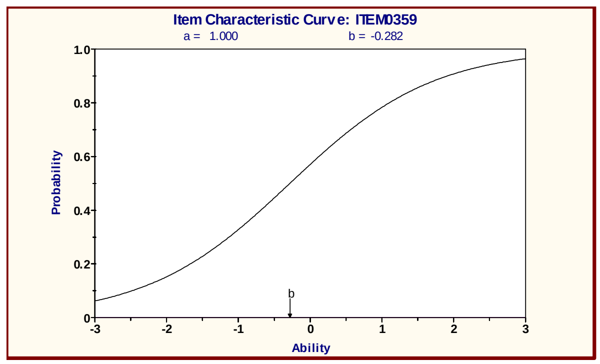


Figure 273. Item Characteristic Curve: Item 0360

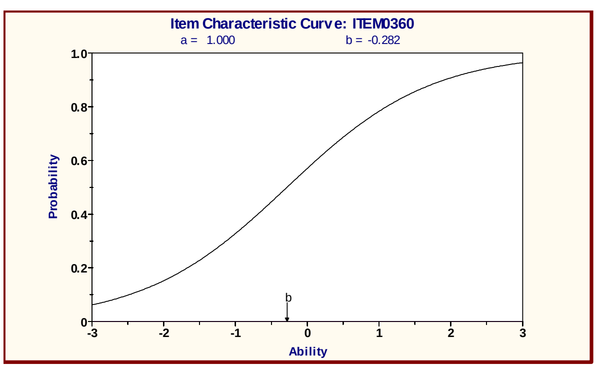


Figure 274. Item Characteristic Curve: Item 0361

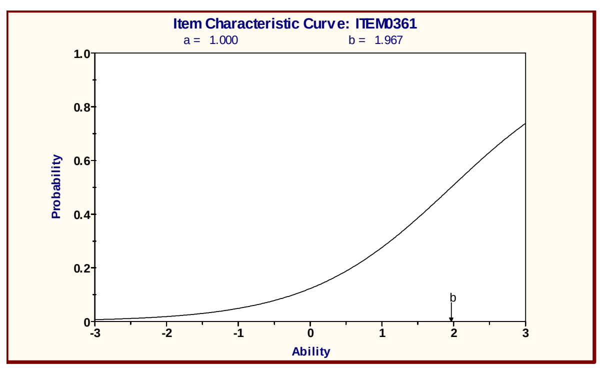


Figure 275. Item Characteristic Curve: Item 0362

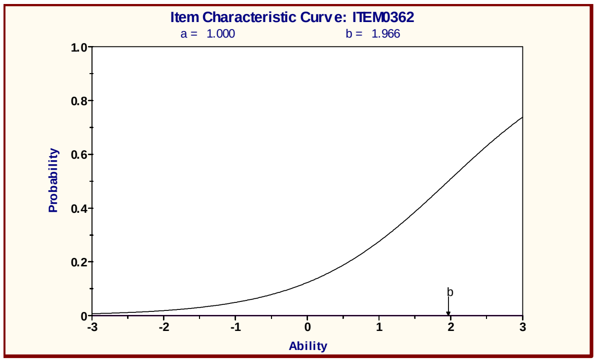


Figure 276. Item Characteristic Curve: Item 0363

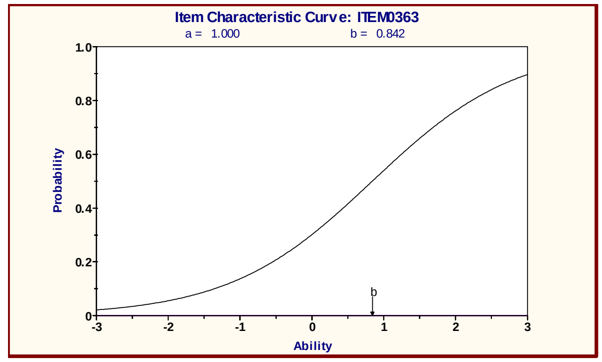


Figure 277. Item Characteristic Curve: Item 0364

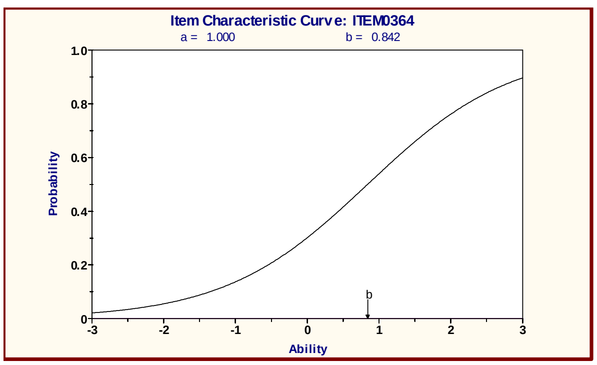


Figure 278. Item Characteristic Curve: Item 0365

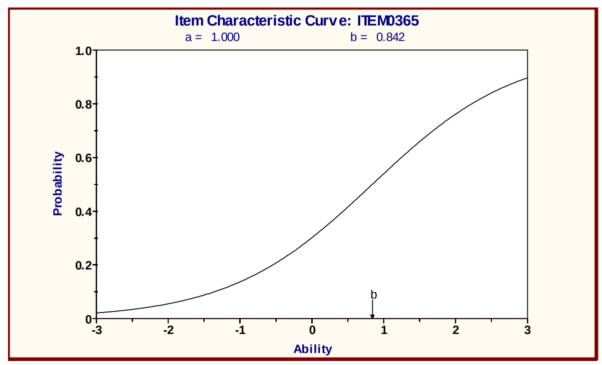


Figure 279. Item Characteristic Curve: Item 0366

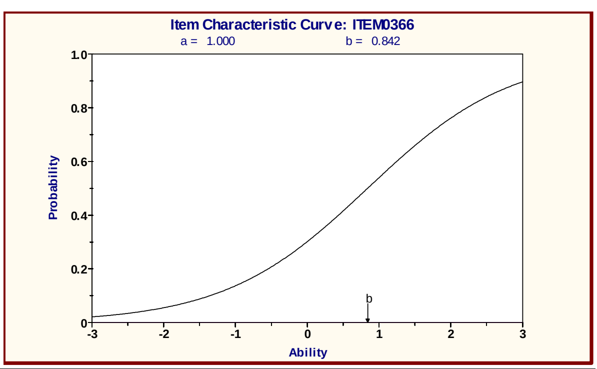


Figure 280. Item Characteristic Curve: Item 0367

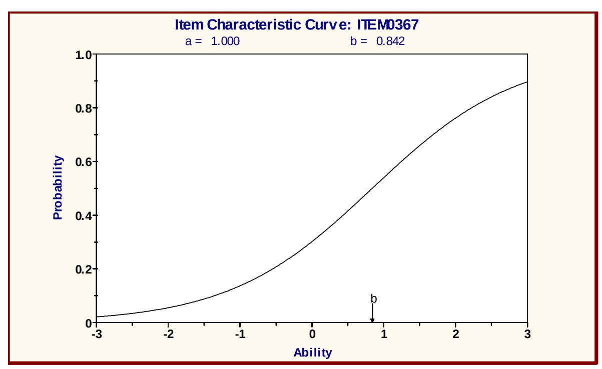


Figure 281. Item Characteristic Curve: Item 0368

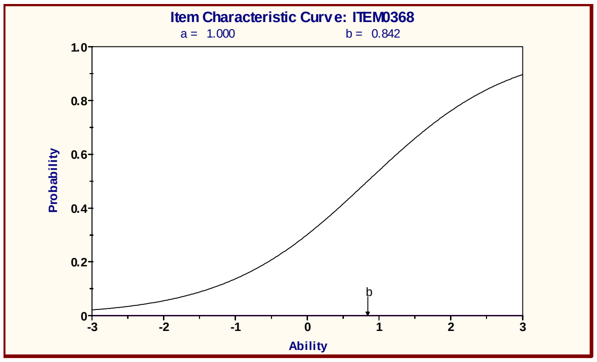


Figure 282. Item Characteristic Curve: Item 0369

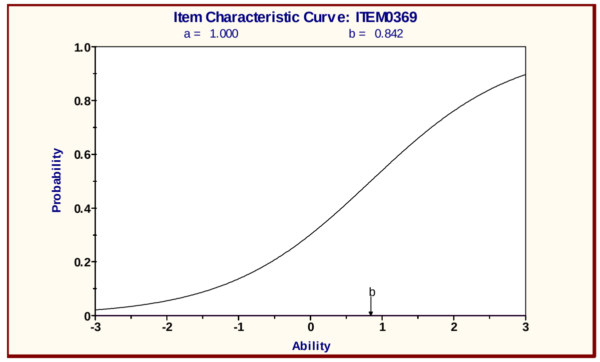


Figure 283. Item Characteristic Curve: Item 0370

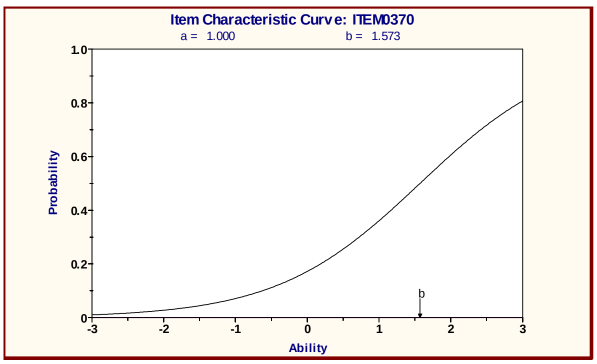


Figure 284. Item Characteristic Curve: Item 0371

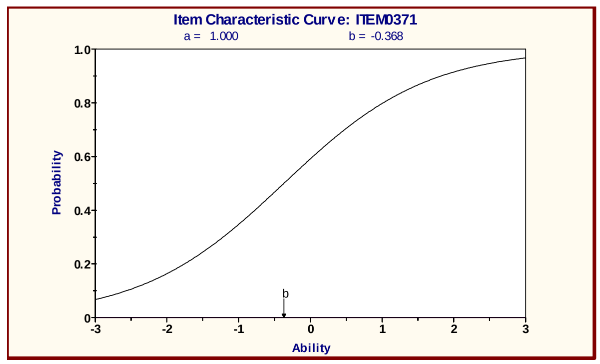


Figure 285. Item Characteristic Curve: Item 0373

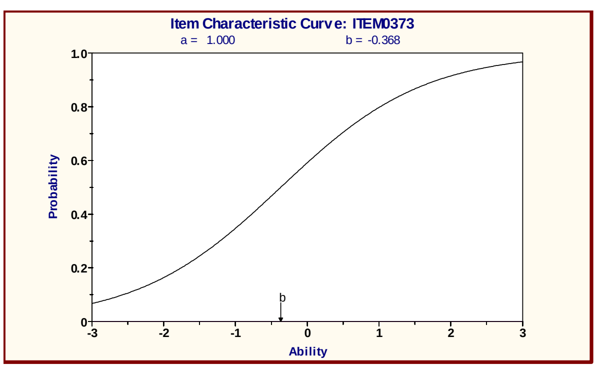


Figure 286. Item Characteristic Curve: Item 0375

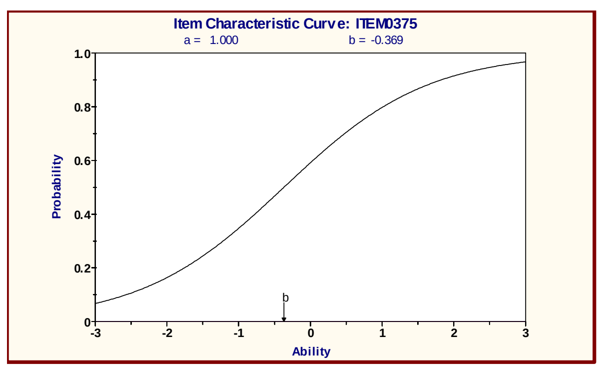


Figure 287. Item Characteristic Curve: Item 0376

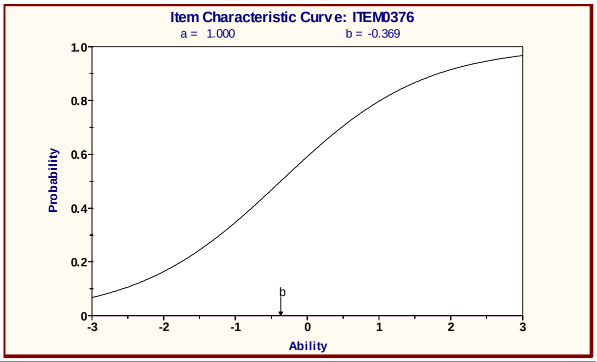


Figure 288. Item Characteristic Curve: Item 0381

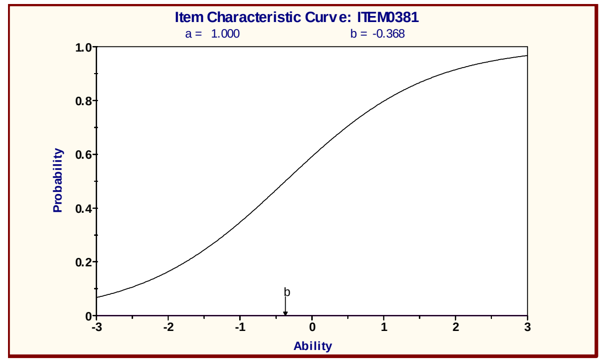


Figure 289. Item Characteristic Curve: Item 0386

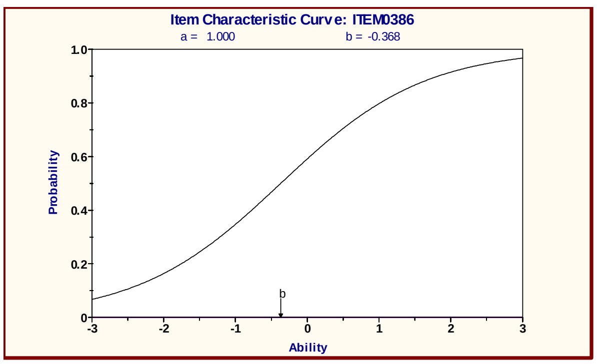


Figure 290. Item Characteristic Curve: Item 0387

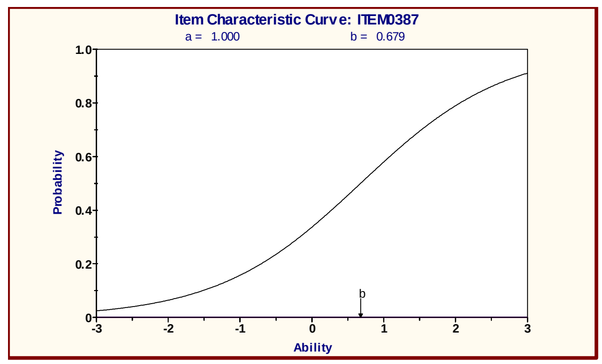


Figure 291. Item Characteristic Curve: Item 0388

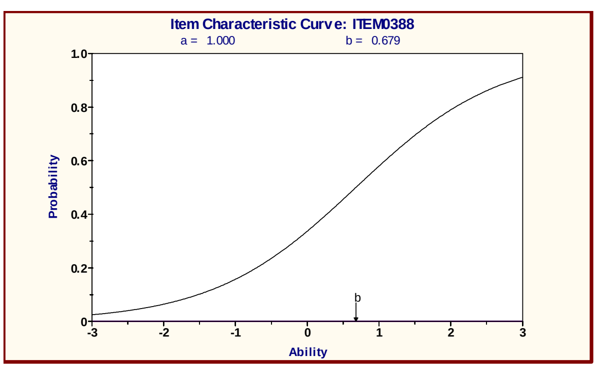


Figure 292 .Item Characteristic Curve: Item 0389

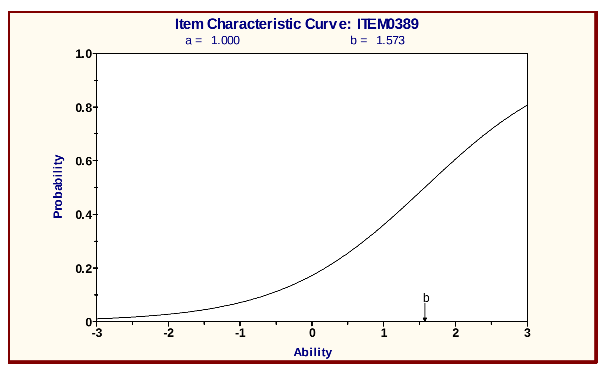


Figure 293. Item Characteristic Curve: Item 0390

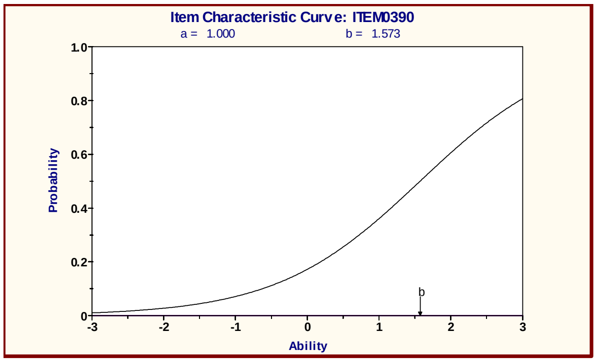


Figure 294. Item Characteristic Curve: Item 0391

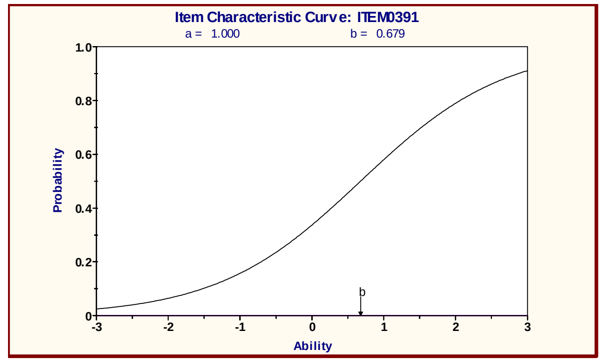


Figure 295. Item Characteristic Curve: Item 0392

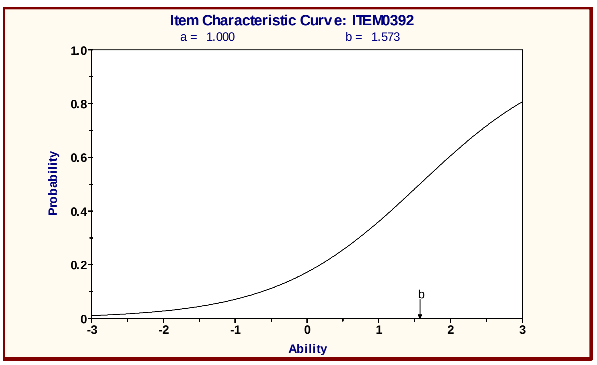


Figure 296. Item Characteristic Curve: Item 0393

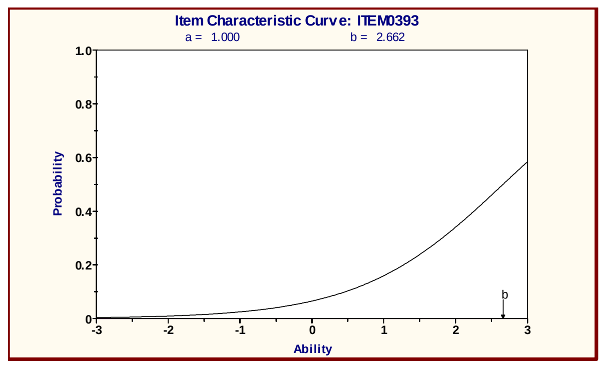


Figure 297. Item Characteristic Curve: Item 0394

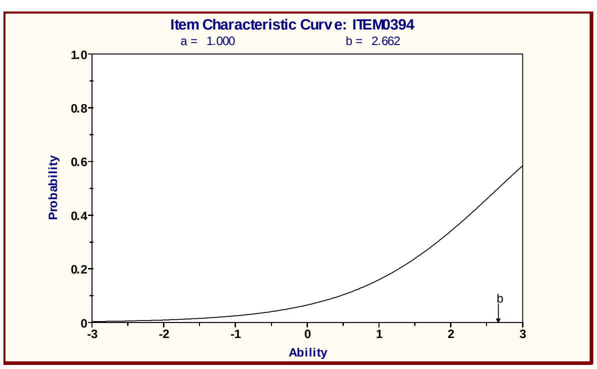


Figure 298. Item Characteristic Curve: Item 0396

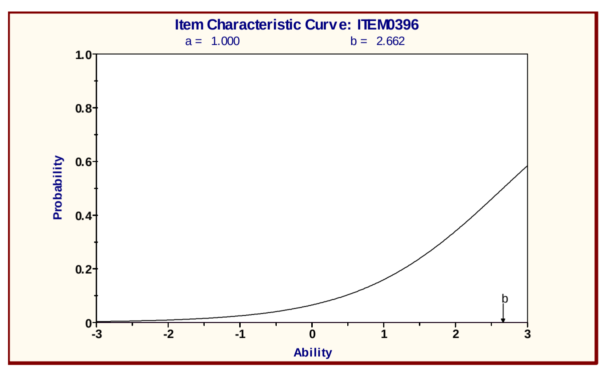


Figure 299. Item Characteristic Curve: Item 0397

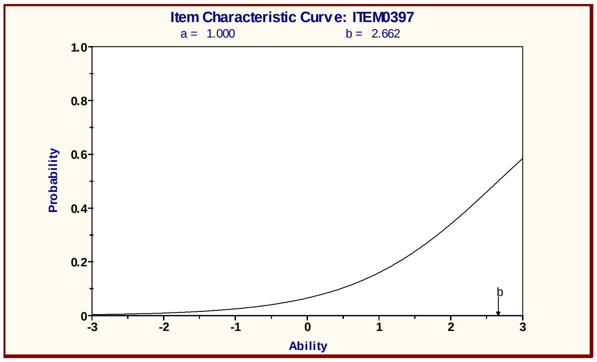


Figure 300. Item Characteristic Curve: Item 0398

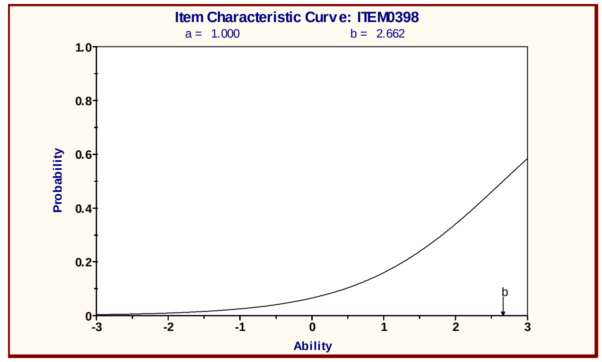


Figure 301. Item Characteristic Curve: Item 0402

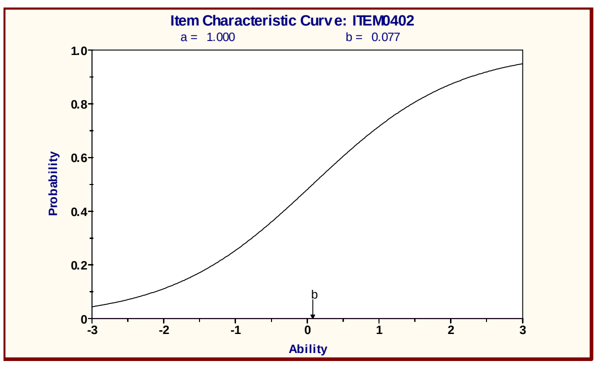


Figure 302. Item Characteristic Curve: Item 0403

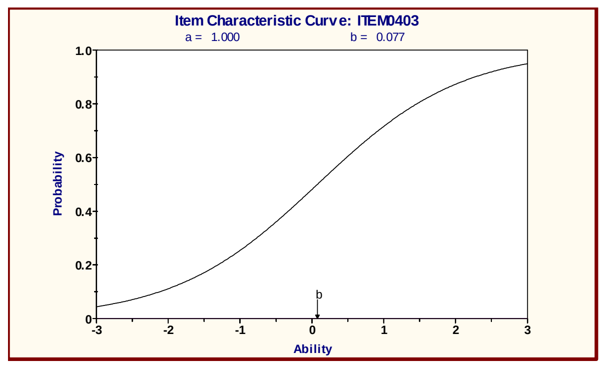


Figure 303. Item Characteristic Curve: Item 0404

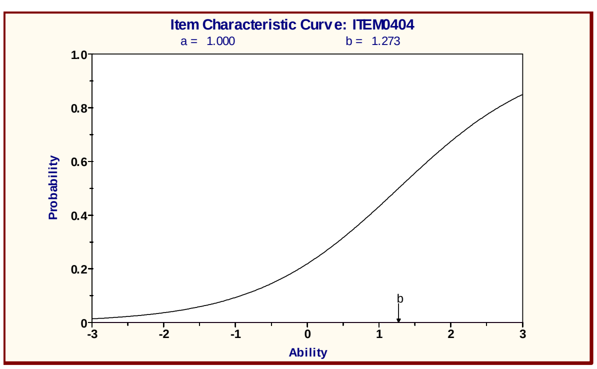


Figure 304. Item Characteristic Curve: Item 0408

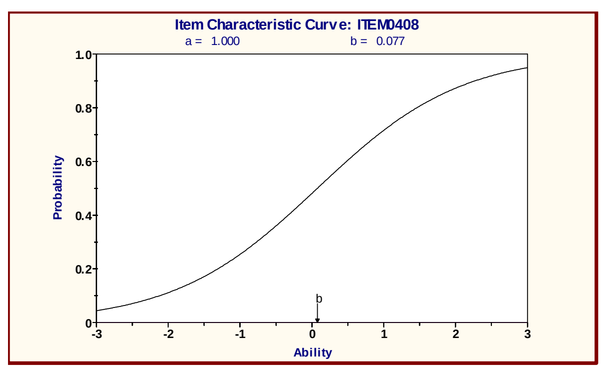


Figure 305. Item Characteristic Curve: Item 0410

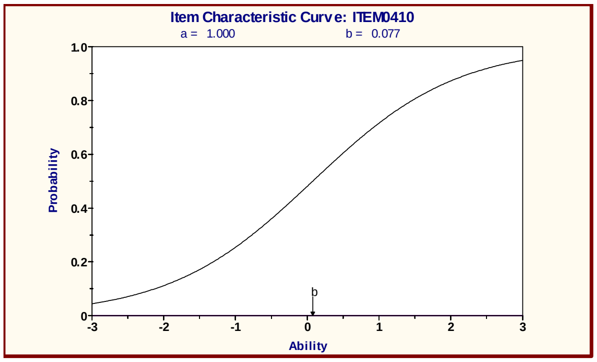


Figure 306. Item Characteristic Curve: Item 0411

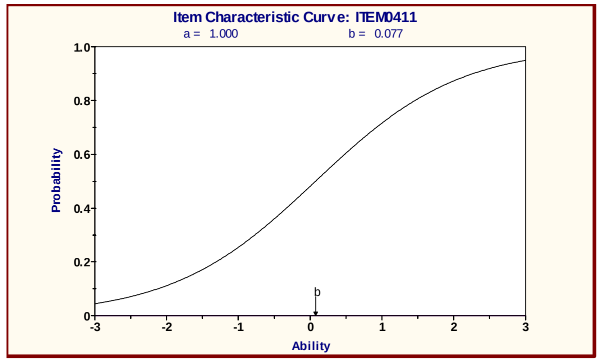


Figure 307. Item Characteristic Curve: Item 0412

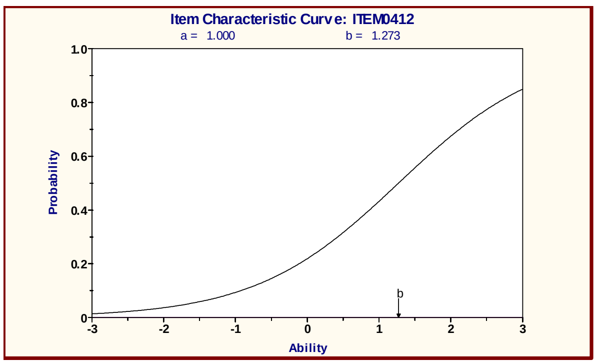


Figure 308. Item Characteristic Curve: Item 0413

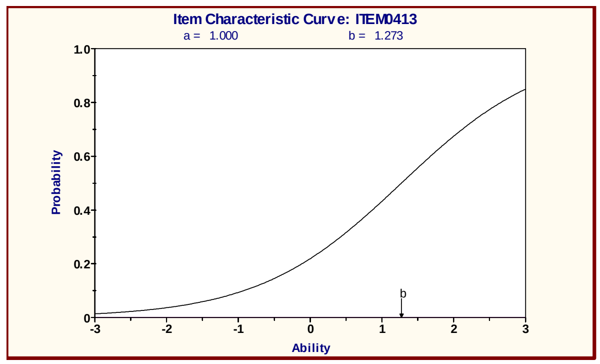
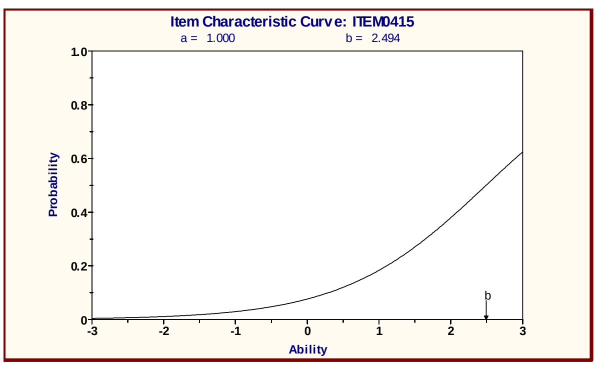


Figure 309. Item Characteristic Curve: Item 0415



Discussion

The core of the research was focused on student acquisition of history facts using study guides and assistive technology. The study involved: (1) ensuring the quality of the study guides, and (2) determining whether a study guide with computer digitized speech improved the ability of 15 students with reading disabilities to answer daily comprehension questions in their U.S. history class. A bank of four hundred fifteen (415) questions based on each chapter of the textbook were developed. During each class period students typically answered 20 to 25 questions, with five of them using assistive technology. The questions were marked either correct (1) or incorrect (0). The codes 1 and 0 were recorded.

The Rasch model was used to calibrate the difficulties of the questions and abilities of the students (Bond, T. G. & Fox C. M. 2001). Next, the Rasch model provided a fit verification. Specifically, the Rasch model was used to develop statistics to determine how well the items fit within the underlying history construct. Items that did not fit the unidimensional construct (the ideal straight line) were those that diverged unacceptably from the expected ability/difficulty pattern. Therefore, the Rasch model was used as a fit statistics to help determine whether the item estimations (answers to the study guide questions) should be held as meaningful quantitative summaries of U. S. history.

The Rasch model determined the students' ability to answer the study guide questions. The traditional total score (e.g., the sum of the item ratings) was the starting point for estimating probabilities of responding. The Rasch model is based on the ideas that: (1) students are more likely to answer easy items correctly rather than difficult items, and (2) more items are likely to be answered correctly by students of high ability than by those of low ability. These simple concepts led the Rasch model to order the items from least to most difficult. Based on this logic of order, the Rasch analysis software, Bilog, performed a logarithmic transformation of the item and person data converting ordinal data to yield interval data.

The student ability and item difficulty estimates, having been subjected to a log transformation, are displayed in Table 2 as a logit (log odds unit) scale. The logit scale is an interval scale in which the unit intervals between the locations on the person-item map have a consistent value or meaning. Logits, in which a logit value of 0- is arbitrarily set as the average, or mean, is the item difficulty estimate. Thus, item 29 is near average on the scale, items 8 and 10 are easier, having negative logit scores, whereas items 1 through 8 have –99.99 logit scores - such that all students answered the questions correctly. Questions 43, and 44 have positive logit estimates, meaning that they are progressively more difficult.

Following down the logit column in Table 2 shows a pattern for the start and finish of each study guide. The concentration of –99.99, large negative numbers or 0.00 shows the start of each study guide. Most of the students could answer most or all the questions at the beginning of the guides. Four study guides ended with questions equal or easier than the beginning questions. Of the other thirteen study guides the questions increased in difficulty as less students answered the questions correctly and the logit scores became higher at the end of the study guides. Seventeen study guides were used. Table 6 shows the logit score at the start and end of each study guide.

Table 6

Study Guide Start and End logit scores

Study Guide Number	Start	Logit	End	Logit
Study guide 1	Item 0001	-99.99	Item 21	-0.41
Study guide 2	Item 0022	-1.61	Item 45	1.61
Study guide 3	Item 0046	-99.99	Item 68	-0.41
Study guide 4	Item 0069	-2.08	Item 86	0.69
Study guide 5	Item 0087	0.00	Item 115	0.00
Study guide 6	Item 0116	-1.25	Item 135	-1.25
Study guide 7	Item 0136	-1.79	Item 167	1.95
Study guide 8	Item 0168	-1.79	Item 200	1.79
Study guide 9	Item 0201	-1.39	Item 218	-99.99
Study guide 10	Item 0219	-99.99	Item 242	99.99
Study guide 11	Item 0243	-1.10	Item 266	1.10
Study guide 12	Item 0267	-0.92	Item 292	99.99
Study guide 13	Item 0293	-99.99	Item 313	1.61
Study guide 14	Item 0314	-0.69	Item 338	99.99
Study guide 15	Item 0339	-99.99	Item 378	-99.99
Study guide 16	Item 0379	-99.99	Item 398	1.39
Study guide 17	Item 0399	-99.99	Item 415	1.10

The above data suggests that the study guides generally followed the easier to harder question hierarchy.

The item characteristic curves (ICC) were plotted using the student's ability over the probability of correctly answering each question. Figures 1-309 are ICC graphs using the 309 questions/items in the study guides. Questions that were answered correctly by all students (equal to 0) were not plotted. "B" represents the item's difficulty. A higher "b" parameter indicates that the question is more difficult. Although there is no "correct" difficulty for any one item, it is clearly desirable that the difficulty of the study guide questions should be centered on the average ability of students. Of the three hundred nine (309) questions plotted, one hundred twenty-three (123) questions fell outside -1 to +1 ability, suggesting those questions were either extremely easy (-) or extremely hard (+). Of the remaining one hundred eighty-six (186) questions, ninety-one (91) questions fell between the 0 and –1 range and ninety-five (95) questions fell between the 0 and +1 range. Questions below 0 have a higher probability of students with very little ability choosing the correct answer. Based on the ICC curves the items between -1 and +1 are depicted in Table 7. The questions fall equally with ninety (90) questions between 0 and -1 and ninety (90) questions between 0 and +1.

Table 7

Study Guide Items based on ability between -1 and +1

ITEM	ABILITY		
Study Guide	Between 0 and -1	100% correct	Between 0 and +1
Ch.1 Sec. 3			
001		X	
002		X	
003		X	
004		X	
005		X	
007		X	
008	X		
009		X	
010	X		
011	X		
012		X	
013		X	
014	X		
016			X
017	X		
018			X

019			
020	X		
021	X		X
Ch. 1 Sec. 4			
022	X		
023	X		
024	X		
025			X
026			X
027			X
028			X
Ch. 2 Sec. 1			
045		X	
046		X	
047		X	
048		X	
049		X	
050		X	
051		X	
052		X	
053	X		
054			X
055		X	
056	X		
058	X		
059			X

060			X
061			X
062			X
063			X
064			X
065	X		
067			X
068			X
Ch. 2 Sec. 2			
069			X
070		X	
071		X	
072		X	
074		X	
075			X
076			X
077			X
078			X
080			X
Ch. 3 Sec. 1			
087			X
089	X		
090			X
091	X		
092	X		
093	X		

094	X		
095	X		
097	X		
098			X
099	X		
100	X		
101	X		
102			X
104	X		
105	X		
107			X
109			X
110			X
113			X
114			X
115			X
Ch. 4 Sec 1			
116	X		
118	X		
119		X	
121		X	
123	X		
124	X		
126	X		
127	X		
130	X		
131			X

132	X		
133	X		
134	X		
135	X		
Ch. 4 Sec. 2			
137		X	
143	X		
144	X		
145			X
146			X
147			X
155		X	
157		X	
Ch. 5 Sec. 1			
169	X		
173		X	
176			X
177			X
178	X		
180			X
181	X		
182	X		
183	X		
184			X
185	X		
186	X		
189	X		

Ch. 5 Sec, 3			
201	X		
202	X		
203	X		
204			X
205			X
206			X
207		X	
208	X		
209	X		
210	X		
211		X	
212		X	
214	X		
215		X	
217	X		
218		X	
Ch. 5 Sec. 4			
219		X	
220		X	
221		X	
222			X
223			X
224			X
225		X	
226			X
227			X

228			X
229		X	
230			X
231			X
232			X
233		X	
234			X
235		X	
236		X	
237			X
238		X	
239		X	
240		X	
241		X	
242		X	
Ch. 7 Sec. 1			
243	X		
244	X		
245			X
246			X
247	X		
248	X		
249		X	
250	X		
251		X	
252		X	
253		X	

254		X	
255		X	
256			X
258			X
259			X
260			X
261			X
262			X
263			X
264			X
265		X	
Ch. 7 Sec. 3			
267	X		
268		X	
270		X	
271	X		
272		X	
274		X	
275	X		
276	X		
277	X		
278	X		
279			X
285			X
286			X
291		X	
292		X	

Ch. 12 Sec. 1			
293		X	
294	X		
295		X	
296		X	
297		X	
298		X	
299	X		
300		X	
301		X	
302		X	
303			X
304		X	
305		X	
307	X		
308			X
Ch. 12 Sec. 2			
314	X		
315	X		
316	X		
317			X
319			X
320	X		
321	X		
322		X	
326			X
328	X		

329	X		
332	X		
333	X		
335		X	
336		X	
337		X	
338		X	
Ch. 14 Sec. 1			
339		X	
340		X	
341		X	
342		X	
343		X	
344		X	
345		X	
346		X	
347	X		
348	X		
349		X	
350		X	
351		X	
352	X		
353		X	
354		X	
355	X		
356	X		
357			X

358			X
359	X		
360	X		
363			X
364			X
365			X
366			X
367			X
368			X
369			X
Ch. 15 Sec. 1			
371	X		
372		X	
373	X		
374		X	
375	X		
376	X		
378		X	
379		X	
380		X	
381	X		
382		X	
383		X	
384		X	
385		X	
386			X
387			X

388			X
391			X
395		X	
Ch. 17 Sec. 3			
399		X	
400		X	
401		X	
402			X
403			X
405		X	
406		X	
407		X	
408			X
409		X	
410			X
411			X
414		X	

Based on the ICC graphs some study guides had a small amount of questions between -1 and +1 ability. For example, Chapter 1 Section 4 study guide had only seven (7) questions between -1 and +1 ability. The low number of questions suggests that more questions should be made to accommodate the ability of the students for this particular chapter in the text book. Table 7 makes it easy to locate questions to individualize or adjust the study guide questions to correlate with student ability.

With the Rasch model based on unidimensionality: examination of only one human attribute at a time on a hierarchical “more than/less than” line of inquiry (Bond, T. & Fox, C. 2001). The concept of fit was considered hand-in-hand with that of unidimensionality. The person and item performance deviations from the line (fit) were assessed with the *Outfit* and *Infit* scores, shown in Table 3. Item fit estimates are expressed with chi-square fit statistics to determine how well the study-guide data met the requirements of the Rasch model. *Outfit* is based on the conventional sum of squared standardized residuals for each item and Infit is the standard deviation of the variance for each item. The values > 1.3 were considered unpredictable, with too much variation, and were considered an under fit. The values <0.75 were considered to rigid, with too little variation, and were considered an over fit. Fifty-two (52) items were ether over fit or under fit. Table 3 lists the misfit order for the fifty-two (52) questions. Three hundred sixty-three (363) questions were considered “better fitting”, suggesting that the majority of the study guide questions fit the U.S. history hierarchical line of inquiry.

The point biserial correlation in Table 2 is a quality estimate, in this study it is used to determine the quality of the study guide questions. A large positive point-biserial value indicates that students with high scores on the overall test are also answering the item correctly (which we would expect) and that students with low scores on the overall test are answering the item incorrectly (which we also would expect). Generally, a low point-biserial implies that students who did answer an item correctly tended to do poorly on the overall test (which would indicate an anomaly) and that students who did answer the item incorrectly tended to do well on the test (also an anomaly). Table 1 had eighty-seven (87) negative point-biserial correlation items, one hundred two (102) items with point-biserial correlations equal to 0.00, and eighteen (18) items with point-biserial correlations below 0.15. The question was asked if the Rasch model assessed the validity of the study guide questions? The point-biserial was added to the Bilog print out, but the point-biserial not the Rasch model was used to determine the quality of the study guide questions.

The objective of each study guide was to help most students answer the questions correctly. A study guide was "doing it's job" if it was easy for a student to comprehend the history text. Therefore, "zero" point-biserials for the study guide was considered "good". The pattern in Table 2's "Correlation Biserial" column shows that each study guide starts with a sequence of zeros. The point-biserial gradually gets larger showing that items get harder or answered by fewer students toward the end of the study guides.

Low point-biserial and negative point-biserial correlations present another type of "issue" about the quality of the questions. The fact of eighteen (18) items with low point- biserial correlation (4.3%) suggest that something in the wording, presentation or content of the items may be causing the low point-biserial correlation. The negative point-biserial items (20%) suggest that the items may represent a different content area entirely. The negative point-biserial suggests that the study guide questions were measuring something entirely different than that measured by the rest of the test (multidimensionality) or that an item was so poorly written that it caused students to be confused when responding to it. On one hand, approximately twenty-five (25) percent of the questions are problematic items or "misfitting" items. On the other hand, seventy-five (75) percent of the study-guide questions could be deemed of "good" quality.

A test's reliability - generally tells the researcher whether a test is likely to yield the same results when administered to the same group of test-takers multiple times. The Rasch model gives two reliability estimates: (1) the item reliability, and (2) the student/person reliability. The item reliability of .95 indicated the replicability of item placements along the pathway if these same items were given to another sample with comparable ability levels (see Table 4). Therefore, high person reliability means that this study developed a line of inquiry in which some students score higher and some score lower, and that confidence should be placed in the consistency of these inferences. Using the Kuder-Richardson formula for reliability as delineated by Ary, Jacobs, and Razavieh (2002), the reliability of .97 was calculated, which suggested a homogeneous domain, and higher inter-item consistency.

The Student reliability of .25 suggests that if other students were given these same study guide questions, the item estimates would not be highly stable. With the low item reliability, we can infer that the some of the study guide items are more difficult and some items easier, and that not a lot of confidence can be placed in the consistency of these inferences. With an Item reliability of .25 the study-guide replicability is low.

Therefore, based on the person estimate, we have better information about the students than about the items. In other words, the four hundred fifteen (415) items gave us a greater amount of reliable information about the fifteen (15) students than the fifteen (15) students gave about the four hundred fifteen (415) items. With a .95 person reliability, the data from the study guides are a reliable estimate of ability of the students in the U.S. history class.

Below, Table 8 shows ability, student number and error, ability is either negative (lower ability) or plus (higher ability). Student Three had the highest ability and Student Ten had the lowest ability. Each student’s ability had an error estimate as well. Note that Students Three, Five, Twelve, and Fourteen had high error because each only tried to answer less than seventy questions. Their ability estimates contains more uncertainty because there are not as many items in their observation schedule targeted at their level of ability. Student Nine, ranking the second highest ability, and Student Ten, with the lowest ability, have lower error estimates, suggesting they have more detailed information to estimate their ability level accurately. Student Nine answered two hundred sixty-nine (269) questions and Student Ten answered one hundred forty-nine (149) questions with errors estimates of .17 and .20. respectively.

Table 8

Students sorted by ability with standard error

Ability	Student	Error
2.7184	Three	0.3907
2.3224	Nine	0.1704
1.8449	Twelve	0.3133
1.2171	Eleven	0.1500
0.9823	Fifteen	0.1482
0.596	Six	0.1486
0.5474	Eight	0.1905
0.51	Seven	0.1555
0.404	Fourteen	0.3447
0.3455	Thirteen	0.2386
0.107	Four	0.1761
-0.6817	Five	0.3007
-.9805	Ten	0.2055

Students Four, Six, Nine, Thirteen, and Fifteen used assistive technology. The descending order of ability of students that used assistive technology is depicted in Table 9 below:

Table 9

Students sorted by ability using assistive technology

Ability	Student
2.3224	Nine
0.9323	Fifteen
0.596	Six
0.3455	Thirteen
0.107	Four

When using assistive technology students with the lowest reading ability did not have the lowest ability to answer study guide questions.

One student was randomly selected from the five described in Table 8 to determine if that student’s ability to answer more questions was influenced by the use of assistive technology. Using the procedure outline by Glass to select random samples, number nine (9) was selected from the table of random numbers. Student Nine did not use the computer for the first four assignments (the baseline phase). Next, Student Nine used the computer to complete the next four study guides, (the treatment phase). Then, Student Nine did not use the computer to complete the next five study guides. Lastly, three study guides were completed by Student Nine - using the computer. This design is symbolized in Table 10:

Table 10

Single Subject Design with comparison between phases

OOOO Baseline phase		XOXO Treatment phase		OOOOO Baseline phase		XOX Treatment phase
T test	-3.02		3.86		-4.0	

The t test was calculated using the t test method outlined by Ary, Jacobs, and Razavieh (2002) between each phase. Each phase was significant. Between the first and second phase, when no computer use was compared to computer use, there was a significant negative effect at the .05 level. Between the second and third phases, when technology use was compared to no use, Student Nine had significant improvement in answering the study guide questions, at the .01 level. Between the third and forth phases Student Nine answered significantly fewer questions when no computer use was compared to computer use at the .01 level. Student Nine reported a significantly greater ability to answer questions when using assistive technology.

This analysis suggests that Student Nine was significantly able to answer study guide questions when using assistive technology and digitized speech. Specifically, the use of digitized speech increased the student's ability, such that one student with reading deficits could answer significantly more comprehension questions.

In conclusion, the Rasch model was an invaluable tool to determine the ability of one student with disabilities in using assistive technology and study guides. The Rasch model provided information that made it possible to determine the ability of the student and determine the effectiveness and efficiency of the study guide. The Rasch Model provided logit scores, ICC curves, point-biserial scores, estimation of fit, and reliability estimates The resulting statistics made it possible for, me, the classroom teacher, to create more effective study guides by: (1) eliminating poorly written questions, (2) eliminating questions that were simply not related to U.S. history and (3) eliminating questions that were too easy or too hard. The Rasch statistics made it easy for me, as the teacher, to develop a higher quality study guide that impacted student diagnostics, classroom instruction, curriculum development, all while contributing to my professional development.

The Rasch model statistics made feedback and change more effective. For example the ICC Curves quickly showed which questions were closest to the ability range of the students. It then became theoretically possible for all guide questions to be answered correctly by all of the students based on each student's ability. Thus, the students in the class could answer a smaller number of quality questions versus a large quantity of poor questions.

Two benefits of creating study guides questions based on the ability of the students in the class are: 1) fewer questions on the study guides, giving students using digitized speech - with a fixed reading speed –more time to finish the study guide, and 2) correctly completed study guide questions, possibly affecting class work grades, test grades, and course grades.

Another hidden benefit of the Rasch Model is that it solves the dilemma of grading students with different abilities. If the Rasch model determines a student's ability, then instead of a "class curve" a class grade can be determined with a simple ratio of each student's ability to total score.

A heavy reliance was placed on the Rasch model's ability to manipulate the data of fifteen students to provide information about student ability and study guide effectiveness. The issue remains, just how effective is the Rasch model with a small sample? If the starting point for creating Rasch measures a mean type calculation (the number of items successfully answered divided by the total number of items) and each item (the number of persons successfully passing the item divided by the total number of persons), then, are these mean calculations affected by the extreme scores exhibited in the classroom setting? Specifically, how effective is the Rasch statistic with fifteen (15) students and fifty-two 52 outliers? Corlu, M. S., 2009, suggested that outliers have an increasing effect on mean calculations. He suggests using more robust statistics, such as a Monte Carlo simulation, to test the effects of small samples and outliers.

Although the Rasch model provided very useful information for this study, I recommend further research to: determine the breakdown point for a small sample with possible extreme data contamination that may cause an estimator (such as mean calculations) to take a large or bizarre value when using the Rasch model. Specifically, how effective is the Rasch model with the type of data found in the special education classroom of less than fifteen students and high possibility of extreme data? Given all the recent developments in computer technology, it is easier than ever to use robust methods, such as a Monte Carlo simulation. Perhaps it is time to consider how effective the Rasch Model is with small samples.

As previously discussed, Clark and Mayer (2008) suggested that in special situations on-screen text does not add to the learner's processing demands and can diminishes them. Dowell and Shmueli (2008) suggested that a redundant multimodal display will neither assist nor disrupt understanding when compared with a purely visual display, but it will assist understanding of complex content when compared with speech output alone. Perhaps using on-screen text and audio with reading disabled students is an example of a special situation. This study suggests that students with reading deficits benefited from the auditory and visually displayed text. Raveh and Schiff (2008) takes it one step further and suggest that auditory stimuli not only benefit but has a profound positive affect in word comprehension for reading disabled students.

In the Reveh and Schiff's (2008) study students reading substantially below the expected level of their chronological age, measured intelligence, and educational opportunities were classified with developmental dyslexia. The Reveh and Schiff study found students with dyslexia had morphological awareness comparable to that of the reading-matched control groups when the materials were auditory. When the words were presented in the auditory modality, the students with reading disabilities were able to extract and activate the roots of the prime and the target words comparable to those of students without reading deficits. This was important because they suggested that morphological awareness contributed to reading ability (Carlise, 1995; Carlisle & Nomanbhoy, 1993; Casalis, Cole, & Sopo, 2004; Fowler & Liberman, 1995; Hauerwas & Walker, 2003; Mahony, Singson, & Mann, 2000; Rubin, Patterson, & Kantor, 1991; Singson, Mahony, & Mann, 2000), increased vocabulary, (Carlisle, 1995, 200; Mahony et al., 2000; Shankweiler, D., Crain, S., Katz, L., Fowler, A. E., Liberman, A. E., Brady, S. A., 1995; Singson et al., 200), and text comprehension (Mann, 2000).

Specifically, students that have reading disabilities that persist despite extensive exposure and remedial education may be dyslexic. Dyslexic students have a deficit in their ability to recognize words quickly and effortlessly. Raveh and Schiff used repetition priming to test the ability of dyslexic students to recognize words quickly and effortlessly. A list of words were presented to the student in the study phase and then the student was asked to complete a word stem (e.g., sta_) with the first word that came to their mind. Priming was measured as the increase in the probability of completing the stem with the word seen in the study phase. Samuelsson, S., Gustafson, S., and Ronnberg, J. (1998) also examined repetition priming using the stem completion task in a group of adolescents. Ravah and Schiff and Samuelsson, et al. both found that the phonological dyslexia student exhibited a deficit in the visual repetition task but not with the auditory task.

Raveh and Schiff (2008) suggested that the reason for the auditory modality affect with dyslexia students is that when the dyslexic students lean to read their visual deciphering skills are so weak that they develop their word patterns dependent on their auditory modality. Raveh and Schiff suggested dyslexic students compensate the visual modality with the auditory modality for pattern development and word understanding, morphemic awareness, which continues through adulthood (Elbro & Arnbak, 1996; Schiff & Ravid, 2004, 2007).

Perhaps the reason for the auditory modality affect with dyslexia students can be explained with the cognitive load theory. Sweller (2003, 2004) proposed five principles common to natural information systems. (1) the information story principle, (2) the borrowing principle, (3) the randomness as genesis principle, (4) the narrow limits of change principle, and (5) the environment organizing and linking principle. Based on these principles Sweller (2006) suggests that humans use imitation, listening or reading to load their long term memory with information. Applying Sweller's (2006) randomness as genesis principle to explain why dyslectic students have a modality preference, suggests that students with dyslexia may attempt to solve the problem of visual text and fail, so they attempt to solve the problem by using auditory schemas.

If this is the case, the dyslectic student has adapted the auditory modality to understand written text.

This study assumed that by answering comprehension questions that the student comprehended what they read. This study can only suggest that the students in this study that used assistive technology improved word comprehension which increased the student's ability to comprehend the text. Perhaps, the low reading students that were selected in this study to use the assistive technology – digitized speech, had a predisposition, (i.e. dyslexia), and the auditory modality helped them understand the text. To make a definitive statement about the affects of assistive technology on the reading comprehension of disabled readers requires further study to examine morphological knowledge, the reading processes of students with reading disabilities, and specific factors that influence reading comprehension.

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ABSTRACT

RASCH MODELING: COMPUTER ASSISTIVE TECHNOLOGY IN A HIGH SCHOOL SPECIAL EDUCATION CLASSROOM

by

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The Rasch model was used to determine the ability of a small sample of students with learning disabilities to answer study guide questions when using assistive technology in a high school U.S. history class. The Rasch model was also used to estimate the quality of the study guide questions. The Rasch model was effective in analyzing the study guide questions. The study concluded that students with the lowest reading levels did not have the lowest ability to answer the study guide questions when using computer speech technology. An additional analysis suggested that the use of computer speech technology improved the ability of a single student to answer study guide questions. The stability of the Rasch model with a small sample was questioned and suggested further study should be conducted.

AUTOBIOGRAPHICAL STATEMENT

Frances Dolley has twenty years experience in education. She has worked in industry and in the public education fields, developing, implementing, and evaluating training programs. She received her Bachelors of Science from Eastern Michigan University majoring in special education. She received two Masters of Science: the first from Wayne State University in Educational Testing and Evaluation, and the second from University of Detroit Mercy in special education.