

Running Head: KNOWLEDGE REPRESENTATIONS IN ASSESSMENT

Knowledge Representations driving the Design of Computerized Performance  
Assessments in a complex simulated environment (DRAFT)

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Abstract

A key component of the Cisco Networking Academy Program (CNAP), a public-private partnership (<http://cisco.netacad.net>) which teaches apprentice-level design, installation, and troubleshooting of computer networks, has for years been a hands-on, instructor-administered performance (skills) exam. Such exams when well-administered have formed the “gold standard” for proficiency determination in the program; however given the size of the CNAP (on the order of ten thousand instructors), such exams are too-often characterized by poor psychometric reliability and validity. The evolution of the performance exam towards a partially automated system called the Cisco Network Simulator (CNS) is described. The design of CNS can be viewed by what Mislevy (2005) has described as five key roles for knowledge representations (KRs) in educational assessment. Each of the roles is briefly reviewed, and how these KRs have helped improve the design of CNS is described. We conclude by looking at some of the affordances of computerized KR-based performance exams to meet and exceed the capabilities of the traditional exams.

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The Cisco Networking Academy Program (CNAP, <http://cisco.netacad.net>) prepares students to take the Cisco Certified Network Associate (CCNA) exam, a measure of proficiency at performing apprentice-level jobs as network technicians, administrators, and engineers. In the CNAP, approximately ten thousand instructors teach hundreds of thousands of students in 150 countries a four-semester course sequence. At the end of each learning module or school semester, each student must complete both an on-line multiple-choice exam that primarily measures declarative knowledge and a "traditional", instructor-administered, equipment-intensive performance exam.

The performance exam tests student proficiency in configuring (programming) PCs, switches, and routers to build small model Local Area Networks (LANs) and Wide Area Networks (WANs). This paper describes the evolution from a traditional hands-on exam to a simulation-based computer-administered performance exam with automated scoring of complex work products. Numerous issues regarding the nature of appropriate knowledge representations (KRs) (Markman, 1999) are considered in this migration including a comparison between the two types of summative performance exams, "traditional" and computer-administered.

Using the framing provided by Evidence Centered Design (ECD) (Mislevy, Steinberg, & Almond, 2003; Behrens et al., 2004), we examine how knowledge representations have driven the evolution of the computerized performance assessment system which originally described in the paper by Williamson et al. (2004) into its current form as an application called the Cisco Network Simulator (CNS). Mislevy

(2005) has identified five key roles of KRs in educational assessment. In this paper, we use these five roles as lenses through which to examine the design and development of complex performance assessments in computer networking. As will be shown, the KR focus greatly facilitates CNAP goals for improving the psychometric reliability and validity of summative performance assessments. We conclude with a summary of our plans for data collection.

#### Five Roles for KRs in Networking Performance Assessment Design

Mislevy (2005) has identified five key roles of KRs in educational assessment. In this section, we examine how each of these roles played out over the course of the design process for the Cisco Network Simulator (CNS), a computerized performance assessment system. The CNS may be thought of as two major components: a scoring-and-presentation engine “front end” referred to as “NetPASS” in other research; and a simulation back end (to simulate the behavior of networking devices). For purposes of discussing the five roles of KRs, we will use the general term CNS to describe the system being designed.

Regarding the first role for KRs in assessment, Mislevy (2005) states:

“An assessment is itself is an KR that communicates the targets of learning and the standards of performances to all stakeholders, and its construction serves vital educative purposes before the first student ever sees it. In order to perform well on the assessment, the student must be attuned to the affordances of the assessment as a knowledge representation”

Shown in Figure 1 is the web page seen by a student taking a CNS exam. We can consider the assessment itself as a KR. At the top of the assessment page are a title,

instructions on how to submit the assessment, a timer, and then a variety of “tabs”. Each of these tabs is a domain KR discussed in more detail in the next section. But for now, our focus is on the entirety of Figure 1 – an example of the assessment as KR.

Indeed a vital educative purpose has been served by this KR. Its construction is the result of processes such as curriculum review (what has been presented to the students?), instructional review (in what ways was the student taught the desired skill?), and assessment design (including an ECD framing of what high level proficiency claims are being tested and what evidence, derived from what student work product, will this assessment KR will serve as a prompt?). The assessment KR may be seen as performing a vital coordinating function.

In order to be fair to the students, we had to redesign the GUI affordances -- the location and navigation of the tabs, windows, and other GUI widgets – several times. Much of this GUI redesign was driven by attention to KRs – particularly we were striving for fidelity to other tools students would have used, include real networking devices, remote access to devices, and simulated devices. Redesign for usability is not surprising from a human-computer interactions standpoint, but further illustrates Mislevy’s point about the student having to be attuned the affordances of the assessment as a KR.

In addition to affordances designed into the interface, usage guidelines evolved to allow us to better attune the learners, via practice, to the affordances of a CNS assessment. A practice midterm exam was developed for a lower stakes situation than the final summative assessment, and two parallel forms of the final exam were created. One other crucial affordance in the user interface is the issue of translation. The CNS must serve students in 150 countries, where the curriculum is translated into at least 8 major

languages. While in the field of networking many learners' second language is English, translation does merit mention as another relevant affordance of the assessment as KR. In subsequent sections, we will build upon this notion of the assessment itself as a KR.

In the prior section, we viewed the assessment itself as a KR. Now we look at the domain KRs that are most important in computer networking. What we describe is the evolution of what was presented to students in exam situations to more accurately reflect the domain. Mislevy (2005) states:

“The analysis of any domain in which learning is to be assessed must include the identification and analysis of the KRs in that domain (domain KRs). KRs embody the important ideas and relationships in a domain, and define the language by which people acquire and communicate information in that domain.”

A domain KR of great importance in computer networking is the logical topology, shown in the top part of Figure 2. The logical topology is an abstracted map of the networking device nodes and the interconnections between those nodes. The specific logical topology shown uses icons for PCs (the “end devices” of the Internet) and icons for routers (the “hockey pucks with arrows”; routers are the traffic directing and control devices of the Internet). The lower window shows a bit of the command line interface (CLI) for interacting with the virtual routers. For users familiar with DOS or UNIX, this fragment from Cisco's Internetwork Operating System (IOS) may be a bit familiar – it is the control and programming language for networking switches and routers. Figure 3 shows the *Instruction Tab* selected, with text representation of the assessment question or task the students is being asked to complete. In the lower window, a different router CLI dialog is shown.

Figure 4 shows the primary work product from the student, the running configuration, which is another KR of great importance in computer networking. The running configuration is the result of students using the IOS CLI, say in the bottom of Figures 2 and 3, to issue commands that change the active configuration of the router and its traffic control behavior. For example, in a router, the file which is currently loaded into RAM, and represents the current state of the router's programmed instructions, is called the configuration file. It is similar in many respects to a computer program, only written in the powerful IOS language. The running configuration sets values for processes and enables and disables complex protocols for controlling networking traffic. This vital domain KR is in this case the record of the student's work, also referred to as work product below. As a student works through a configuration task, CNS saves the results of the student's configuration dialog.

Learning to control network traffic via switch and router configuration via the IOS CLI is a primary learning goal throughout the CNAP. It is a core skill that allows a student to move from novice to expert in networking. But without computerized simulations, it is equipment intensive – and equipment is a scarce resource in public educational institutions. Also, configuration file work products are tedious to grade for instructors. Due to differences in the amount of equipment, proficiency of the instructor, and time available to administer such exams, they have been characterized by poor psychometric reliability and validity across the CNAP. CNS has been especially designed to help mitigate these 3 issues.

CNS automatically scores the student work product. Originally in the CNS the student running configuration, once submitted, was not included in the exam results presented to the student or the instructor. Due to system limitations at the time, the CNS did not allow differentiation of instructor and student views. For exam security purposes, the running configuration was not shared with the students. However, we learned from focus groups that despite the convenience of the automated scoring of CNS, the instructors still wanted a copy of the student's running-configuration work product. This turned out to be a key artifact in mediating student grading. If the student made an error, even with the CNS giving system giving feedback, instructors and students still wanted interpersonal interpretation and feedback as well. Instructors also requested the grading rubric being used by CNS for similar reasons, and for legal reasons around the assignment of grades.

Taking a broader perspective, this migration from instructor-intensive to more automated assessment encompasses numerous issues regarding the nature of appropriate knowledge representation in assessment. Issues include realizations of how curricular and assessment activities had been previously constrained by technological limitations that worked well, yet in hindsight, may have led to distorted knowledge representations to conform to the technological limitations of real equipment and real instructors with real time constraints. For example, while the use of real computer networks provides perfect fidelity to certain aspects of the networking world (which computerized simulations can only approximate), in practice, a single configuration of the network can only support gathering data on a fixed range of tasks.

This leads to the establishment of a specific network topology, and focus on tasks and representations associated with that set-up. Accordingly, even in so called “real” networks made up of live networking devices, fidelity to the larger context outside the instructional experience is imperfect and must rely on an analysis of the underlying knowledge and knowledge representation sought. This *limitation* of real equipment being used for performance exams presents is also an *opportunity*: in computerized assessments we can present scaffolding, situations, and tasks to learners – far more KRs and contextualized tasks -- representing a far wider range of networking experiences than would ever be feasible to build and present using real networking equipment in a finite examination time period. Put another way, what we may lose in one type of domain KR fidelity may be compensated by what we gain in fidelity in other relevant domain KRs.

Another issue involving domain KRs is the requirement for CNS to support more networking technologies. Thus far CNS supports one course, Routing, but the architecture can be extended to many technologies, for example switching, advanced routing, network security, and wireless. While many domain KRs are important throughout networking, the possibility is that as the domain in which proficiency is to be sampled expands to more and more networking technologies, some new KRs would have to be incorporated into the design of CNS. This is particularly relevant in networking education at public institutions, where equipment cost is often prohibitive to have the low student-to-equipment ratios for giving meaningful performance exams. Again, to achieve psychometrically reliable and valid assessments in a domain in which equipment can be very expensive and access to equipment limited, careful choice of KRs which adequately represent the domain is a crucial part of the design process.

Having looked at the assessment itself as a KR, and examined in more depth some of the most important domain KRs, we now move to the assessment-as-reasoning-from-evidence process, also illuminated by careful attention to KRs. Mislevy (2005) states:

“Assessment is reasoning about what students know, can do, or have accomplished more broadly, from evidence in a form of a relative handful of particular things they say, do, or make in particular situations. The context in which a student is to act is defined in large part through KRs.”

KRs important in the “assessment as reasoning from evidence” process are summarized in Figures 5, 6, 7, and 8. Figure 5 is student score report, a KR created by applying scoring rules to the student's work product shown in Figure 4. While it appears simple, the meaning of this score report is a proficiency determination with increased psychometric reliability and validity over the traditional instructor-administered and graded exam. It is an impartial, immediately graded assessment, which the instructor can administer simultaneously to an entire class and which the CNAP can use to do item and curriculum analysis. Upon completion of the exam, the students' scores appear in the instructor gradebook (see figure 7). From the gradebook, the instructor can view the “item information page” (IIP). The IIP is shown in Figures 7 and 8, from which an instructor (or student they are coaching) can learn more about what task was presented to the student, what the student's work product response to that task was, and what scoring rubric was applied. Specifically Figure 7 shows the top portion of the IIP, including the student model variables that are used from statistical analysis of student proficiency (Levy and Mislevy, 2004) and item performance. Figure 8 shows the bottom part of the IIP with the grading rubric. Instructor focus groups requested that much of this

information be added to the IIP. These KRs are fundamental in mediating the “grading” process, and while instructors appreciated the automation, they still want to know how it works, both for informing their own professional judgment and for demonstrating to students how their grades were determined. It is interesting to inquire as to whether with increased artificial intelligence-like grading the instructor community would ever be comfortable NOT seeing these KRs.

Mislevy (2005) also notes that the context in which a student is to act is defined largely by the KRs presented to them during the assessment event. One issue that arose in the design of CNS was fidelity to the “real world” of networking and the difficulty of presenting certain aspects of these situations via computer. The CCNA 2 (Routing) course final exam was traditionally administered as a hands-on exam in multiple parts – cabling together networking devices, configuring routing and traffic control on the routers, and troubleshooting. In our attempt to automate the entire exam, our instructor focus groups indicated that we could not adequately simulate the hands-on cabling and connectivity verification part of the exam, and thus could not, in an automated fashion, make valid inferences, without direct observation, about this part of the desired student proficiency. So a hybrid approach was decided upon, one which the instructor focus groups appreciated: a laborious part of the exam could be automated. As long as the running configuration student work product was available, the CNS system proved very popular with instructors. So by accepting some limitations on the KRs and contexts that can and cannot be effectively automated, a more psychometrically reliable and valid exam can be administered.

Carefully using KRs to define the context in which a student must act must be matched by corresponding attention to the KRs collected from the students as evidence of proficiency. In our work with CNS, we encountered a fundamental limitation of the running configuration as a KR. Only certain types of reasoning about student proficiency are possible when the only thing analyzed from the student is the static work product evidence of their final running configuration file. The fact is that during the exam, the student's primary mode of interaction is a DIALOG between the student and the simulated router operating system (IOS) via the command line interface (IOS). Many actions by the student -- ranging from trivial typing errors and low-level syntax errors to more serious semantic and logical errors -- are lost if one does not capture the entire dialog. Also, optimized approaches to design, configuration, and troubleshooting tasks may be obscured if all one looks at is the final correct answer. Said another way, "path information" is lost. Some system responses to student input are of interest to both student and instructor as intermediate records of the student's subsequent decision-making. This indicates that we should consider the analysis of log files (they are already captured by CNS), a simple task since CNS is a computerized system. The log file as a KR is a complete record of student and router interactions during the assessment event, and contains potentially useful formative and summative assessment information.

However, analysis of log files represents a substantially more complex KR, far more difficult to score than a static configuration file. DeMark and Behrens (2004) have taken a statistical language processing approach to analyzing the log files, with promising results especially in classifying learners along a novice to expert curriculum. The potential for more sophisticated and granular diagnostic feedback, adaptive dialogs, and

sophisticated statistical models of learner proficiency far exceeds the possibilities of a non-automated assessment. The log file KR supports a wider range of reasoning from evidence than the static configuration file KR.

Having looked at assessment as a KR, important networking domain KRs, and how KRs support assessment inference processes, we turn now to the possible coordinating and generative roles KRs may play in assessment design. Mislevy (2005) states:

“Design KRs” can be created to organize knowledge about a domain (including its domain KRs) in forms that support the design of instruction and assessment. They can serve to describe salient features of task situations, in ways that both lead to domain representations and to the kinds of reasoning that the student will need to do.”

Design patterns (Wise, 2005) are a form of design KR that became important in our work. The original impetus for this was the desire for parallel forms. Exam security for summative assessments in a large program such as CNAP is a major issue. One approach to improving exam security is to have alternative, parallel final exam forms. In designing such exams to be administered via CNS, we began to ask a larger question related to the desire to create multiple parallel forms – on what archetypal problems of computer networking did we want to examine students?

In seeking to generate multiple parallel forms and forms for practice, we also encountered the question of automating exam authoring. The process for authoring exams in CNS, at present, is still fairly labor intensive. It requires design documents for the exam text, exam graphics, solution configuration files, scoring rule files, and

feedback files, all of which are automated for presentation by direct programming. Subject Matter Experts would prefer a simpler interface for coming up with clever assessment tasks, with improved psychometric reliability and validity characteristics. The design of an authoring tool for CNS will be a primary concern going forward. Such design should be driven by close analysis of design KRs. What we seek is a template-driven design of simulation exam items and entire simulation based exams.

One domain KR of particular interest for the near future of CNS design is the trouble ticket. The trouble ticket is a common way that customer problems are presented to an employee in a Technical Assistance Center (TAC) at Cisco and other networking companies. The intention is to use trouble tickets as a form of scaffolding, of situating the examinee in a more realistic situation. The running configuration can be pre-bugged, and the student examinee would have to read the trouble ticket, access the running configurations, diagnose, isolate, and correct the problem, with log file KRs being the primary work product.

We conclude our review of the roles of KRs in driving the design of CNS with a look at the coordinating and accounting function they can play in assessment design, and how they facilitate the use of rich KRs from the discipline. Mislevy (2005) states:

“KRs from the disciplines of instructional design and assessment design can guide and structure the domain analyses, task construction, and the creation and use of design KRs.”

We found it useful, especially in the process of usability-oriented software design, to consider the overall assessment KR as an artifact in a distributed cognition system which mediates the assessment process. We were struck by an analogy between the Assessment

KR and the Navigation Fix central in Hutchins' (1996) *Cognition in the Wild*. That is, the creation and communication around this summative artifact (KR) drives the computerized assessment design process. This is particularly important in an assessment research group such as ours, where SMEs from very different backgrounds must interact. For example, the CNS system involves the interactions of networking learners (novices to experts), networking instructors, networking subject matter experts, psychometricians, computer programmers – a variety of persons who work on organizationally and geographically distinct curriculum, instruction, and assessment teams. KRs as accounting devices and as a common working vocabulary are crucial for the entire system. From exam design to computer programming to exam interpretation with the student, CNS would not work, and a psychometrically reliable and valid “fix” of student proficiency could not be obtained, without careful attention to a variety of KRs.

Mislevy notes that the discipline KRs can guide the use of design KRs. One example is how we are considering integrating a dynamic KR software environment called Packet Tracer – which gives the students access to, and control over, many of the most important domain KRs in networking. Shown in Figure 9, many KRs are available to the learner to practice and play and obtain feedback. Thus in future iterations of CNS, as Mislevy has suggested, KRs from elsewhere in the process can enrich our palette of design KRs. Another KR that emerged from our research is shown in Figure 10.

Throughout digital electronics, robotics, and programming, the finite state diagram (FSD) is a key KR. We are investigating using FSDs to help drive the authoring curriculum, instructional, and assessment activities.

## Conclusions

The CNS design process described in this paper was greatly informed by a series of instructor focus groups, culminating in an experiment with approximately 80 instructors in a series of usability experiments. The conclusions of that experiment were:

- Instructors found the level of fidelity to real networking equipment sufficient, which CNS achieved by careful management of KRs;
- Instructors valued and trusted the automation of exam administration and grading as long as certain KRs were present
- Instructors still felt they were key aspects of the student learning environment and the assessment process despite the benefits of computerization, especially in the interpretation of KRs.

In the coming months, experiments using the system with numerous students in the CNAP will be performed. Extensive surveying of instructors and students will occur during this phase. As system bugs are worked through, we hope to begin statistical modeling of student proficiency, including correlating scores on the automated performance exams administered through CNS with other measures, such as performance on other online exams and traditional performance assessments.

Finally we will begin to explore the potential of expanding the repertoire of KRs and KR interactivity that the computer uniquely affords. The KR framing has provided a powerful impetus for driving design enhancements and a powerful accounting system for improving the psychometric reliability and validity performance assessments in computer networking.

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Figure 1: CNS Assessment Itself Acts as a KR

CISCO SYSTEMS [Close Window](#)

Assessment System

1. Assessment Selection 2. Assessment Settings 3. Take Assessment

Assessment

### CCNA2 Bridge Skills-Based Assessment

Once you've completed the simulation activity below, click the "Submit Assessment" button below to submit your work for scoring.

WARNING: Don't refresh or re-load this page; don't use the browser's back and forward arrows to leave this page. Doing so will cause the simulation applet to re-initialize, which may cause some of your work to be lost!

Build ferret41 Mon Jan 31 12:53:54 MST 2005 Submit Assessment Time Left: 03:37:22

**Description Tab** Topology Instruction Tab

Your task is to perform basic IGRP and access control list configuration on a three router network, as pictured on the Topology tab.

The following items have been preconfigured on all three routers:

- Hostnames on all routers
- IP addresses and interface descriptions on all interfaces
- All configured interfaces enabled
- Clock rates on DCE interfaces
- The topology cabling
- The passwords: console=cisco, secret=class, vty=cisco

The following table contains the pertinent preconfiguration information for each router:

Router 1	Router 2	Router 3	Host 1	Host 2	Host 3
<pre>System Bootstrap, Version 11.3(2)XA4, RELEASE SOFTWARE (fcl) Copyright (c) 1999 by cisco Systems, Inc. TAC:Home:SW:IOS:Specials for info C2600 platform with 32768 Kbytes of main memory program load complete, entry point: 0x80008000, size: 0x54d718 Self decompressing the image : ##### [OK]</pre>					

[Close Window](#)

Figure 2: Two Key Domain KRs, The Logical Topology (Top) and the Internetwork Operating System (IOS) Command Line Interface (CLI) (Bottom)

Cisco Systems [Close Window](#)

**Assessment System**

1. Assessment Selection
3. Take Assessment

**Assessment**

**CCNA2 Bridge Skills-Based Assessment**

Once you've completed the simulation activity below, click the "Submit Assessment" button below to submit your work for scoring.

WARNING: Don't refresh or re-load this page; don't use the browser's back and forward arrows to leave this page. Doing so will cause the simulation applet to re-initialize, which may cause some of your work to be lost!

Build ferret41 Mon Jan 31 12:53:54 MST 2005
Submit Assessment
Time Left: 03:36:27

Description Tab
Topology
Instruction Tab

```

graph TD
    H1[H1: 172.16.10.2/24] ---|Fa0/0, 172.16.10.1/24 DCE| R1[R1: 172.16.1.2/24]
    R1 ---|S0/0, 172.16.1.1/24 DCE| R2[R2: 172.16.20.2/24]
    R2 ---|Fa0/0, 172.16.20.1/24| H2[H2: 172.16.20.2/24]
    R2 ---|S0/1, 172.16.2.1/24 DCE| R3[R3: 172.16.30.1/24]
    R3 ---|Fa0/0, 172.16.2.2/24| H3[H3: 172.16.30.2/24]
                    
```

Router 1
Router 2
Router 3
Host 1
Host 2
Host 3

```

m000 processor, part number 0, mask 45
Bridging software.
X.25 software, Version 3.0.0.
1 FastEthernet/IEEE 802.3 interface(s)
2 Serial network interface(s)
32K bytes of non-volatile configuration memory.
8192K bytes of processor board System flash (Read/Write)

Press RETURN to get started!

User Access Verification
Password:
                    
```

[Close Window](#)

Figure 3: Multiple Tabs in the CNS Interface

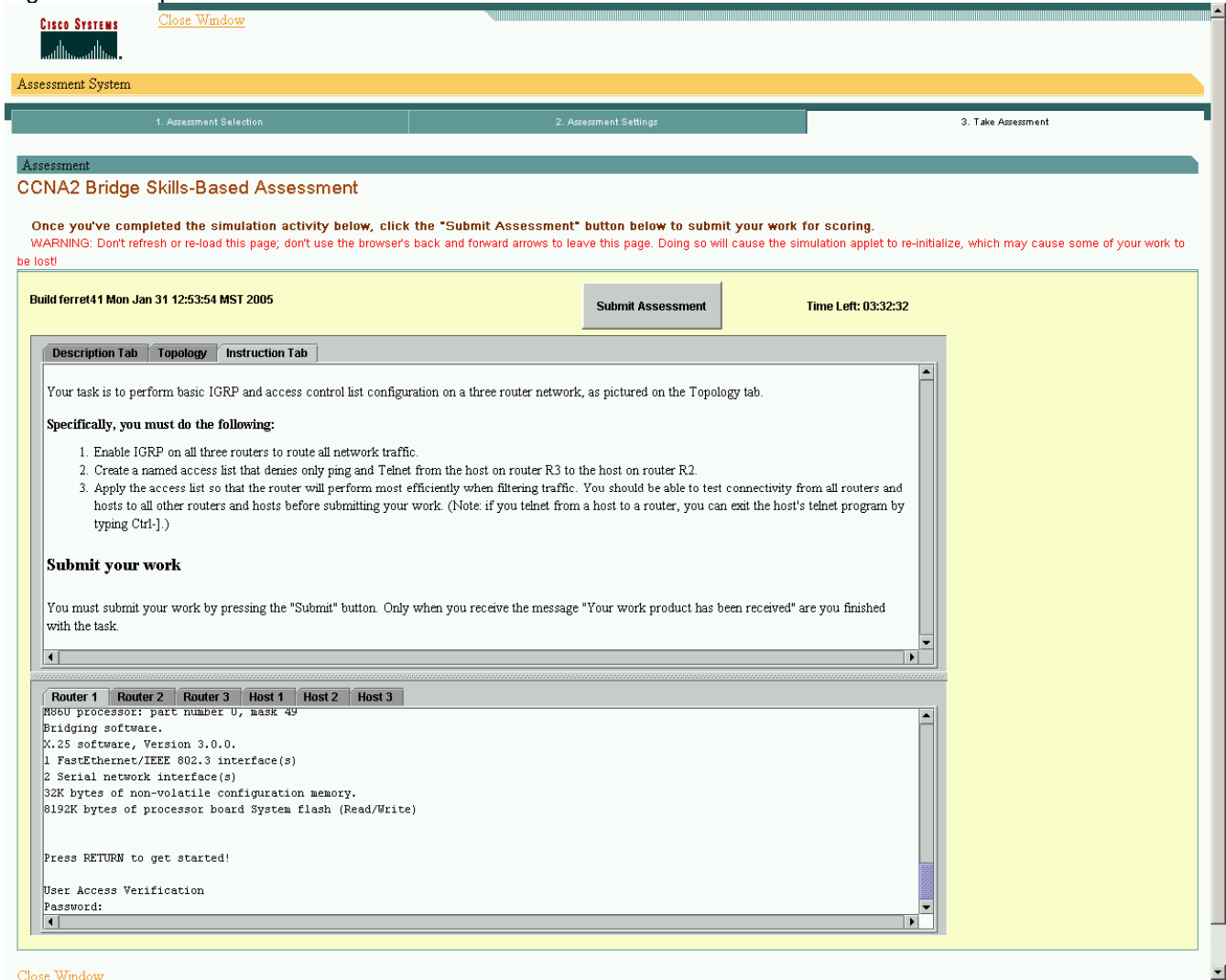
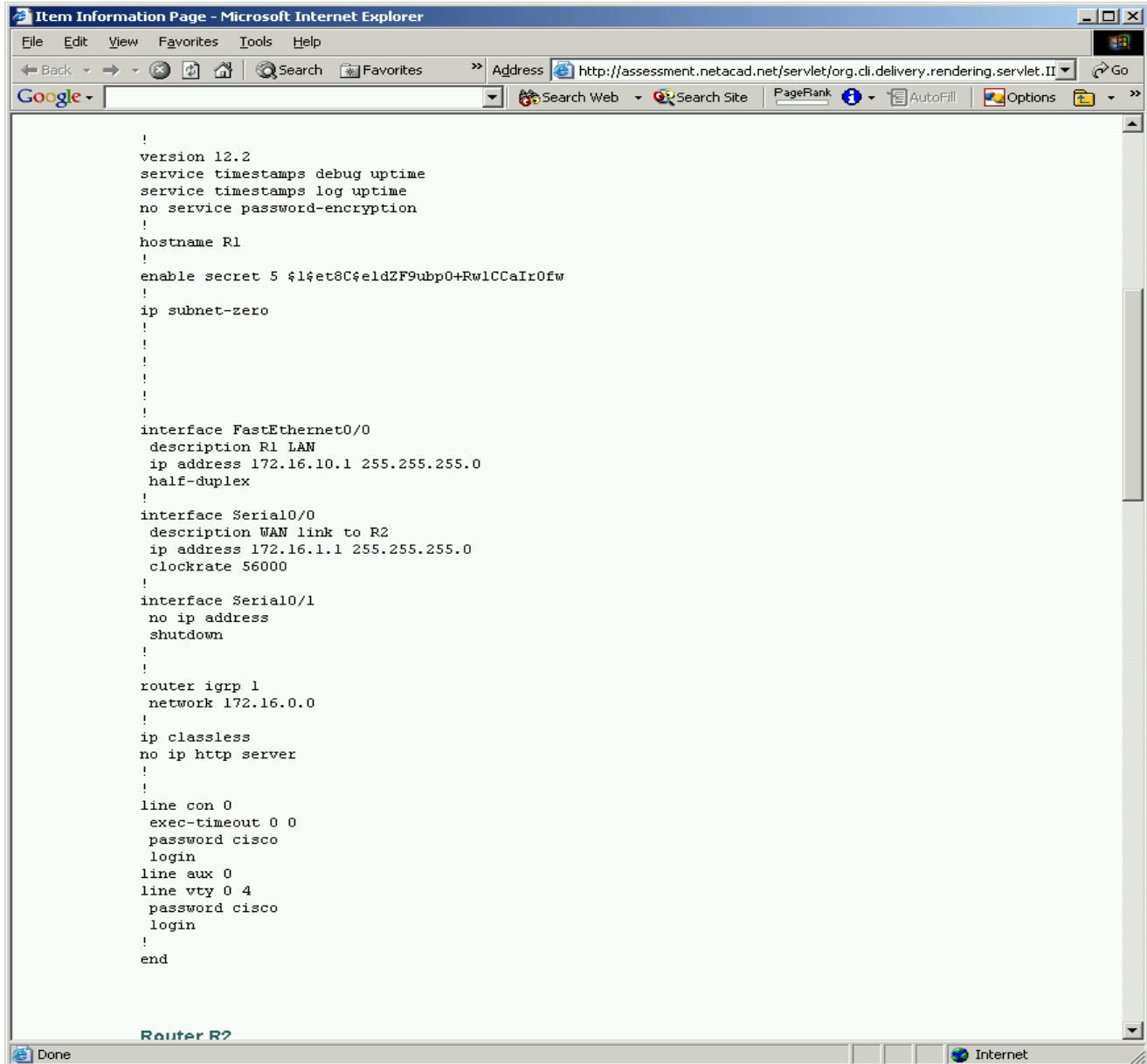


Figure 4: Router Running Configuration File Serves as Student Work Product



```
!
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname R1
!
enable secret 5 $1$et8C$eldZF9ubp0+Rw1CCaIr0fw
!
ip subnet-zero
!
!
!
!
!
!
interface FastEthernet0/0
description R1 LAN
ip address 172.16.10.1 255.255.255.0
half-duplex
!
interface Serial0/0
description WAN link to R2
ip address 172.16.1.1 255.255.255.0
clockrate 56000
!
interface Serial0/1
no ip address
shutdown
!
!
router igrp 1
network 172.16.0.0
!
ip classless
no ip http server
!
!
line con 0
exec-timeout 0 0
password cisco
login
line aux 0
line vty 0 4
password cisco
login
!
end

Router R2
```

Figure 5: Student Proficiency Report

The screenshot shows a Microsoft Internet Explorer browser window displaying a student proficiency report. The address bar shows the URL: [http://assessment.netacad.net/delivery/pub-doc/exam\\_result.shtml?SESSION\\_ID=1112922112728292&ER](http://assessment.netacad.net/delivery/pub-doc/exam_result.shtml?SESSION_ID=1112922112728292&ER). The page features the Cisco Systems logo and a yellow header with the text "Exam Results".

**Exam Results - Skills-Based Final - CCNA 2 Router and Routing Basics - Bridge - Version 3.1B**  
**Date Exam was Taken: 04/07/2005**

Total Score	
Max Points:	11
Earned Points:	6
Percentage:	54.5%
Proficiency Category Name:	You demonstrated partially proficient skills for this exam.

You demonstrated partially proficient skills for this exam.

Figure 6: Instructor Gradebook Demonstrating Automated Grading Feature of CNS

**Gradebook**

**View Gradebook**

Below is the Gradebook for this class displaying the students' scores from their latest exam attempt. Click an exam name to view details of that exam. For information on how to assign grades or results, click the relevant column header. Clicking individual student exam scores will take you to the individual exam results page, which may contain a Proficiency Report and/or Personalized Feedback for that student.

**CCNA2 v3.1 test do not enroll**

View by: Student Name

**Class Information**

Class Name: CCNA2 v3.1 test do not enroll  
 Class ID: 3215975  
 Course: CCNA 2 Bridge Course  
 Version: 3.1

	Module 8 Exam	Module 9 Exam	Module 11 Exam	Final Exam	Skills-Based Final	Skills Exam	Custom Scores	Weighted Percentage	Grades	Eligible for Certificate	Eligible for Letter	Result	
Weight (Totals 100)	20	20	20	20	20	0	0						Weight (Totals 100)
View Item Information					<input checked="" type="checkbox"/>								View Item Information
<a href="#">Brad Anderson</a>	-	-	-	-	54.5			10.9				F	<a href="#">Brad Anderson</a>
<a href="#">Ken Stanley</a>	-	-	-	-	-			0.0				E	<a href="#">Ken Stanley</a>

Figure 7: Item Information Page 1 Including Student Model Variables, Feedback, and Work Product

**Item Information Page - Total Score**

Below you will find the question as it was presented during the exam and the scoring rules associated with the item. Because this item is provided by an external assessment subsystem, student responses are not available for viewing.

**General Information**

Name = Skills-Based Final

**Student-Model Variables**

SMV Name = Total Score  
Maximum Score = 11

**Feedback**

- Review the methods of constructing named access lists. After the access list is named, the format is to deny a protocol followed by source address, destination address, and finally the part of the protocol to be denied.
- You have a complete understanding of enabling the IGRP routing protocol and the publishing of the correct active networks.
- Please review the interface to which you have assigned the access list as well as the direction in which it is applied.

**Solution (Running Configurations)**

**Router R1**

```
!
version 12.2
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname R1
!
enable secret 5 $1&et8C&eld2F9ubp0+Rw1CCaIr0fw
!
ip subnet-zero
!
!
!
```

Figure 8: Item Information Page 2, Including Scoring Rubric and Observables

The screenshot shows a Microsoft Internet Explorer browser window titled "Item Information Page - Microsoft Internet Explorer". The address bar displays the URL: `http://assessment.netacad.net/servlet/org.cli.delivery.rendering.servlet.II`. The main content area contains a Cisco IOS configuration script:

```

!
interface Serial0/0
  no ip address
  shutdown
!
interface Serial0/1
  description WAN link to R2
  ip address 172.16.2.2 255.255.255.0
!
!
router igrp 1
  network 172.16.0.0
!
!
ip classless
no ip http server
!
!
line con 0
  exec-timeout 0 0
  password cisco
  login
line aux 0
line vty 0 4
  password cisco
  login
!
end
    
```

Below the configuration script, there are three scoring rules, each with a description, a Max Value field, and an Earned Value field:

- Scoring Rule For: Routing Protocol Observable**  
 Measures how well students do at configuring RIP and IGRP routing protocols.  
 Max Value = 6      Earned Value = 6
- Scoring Rule For: Access List Application Observable**  
 Measures how well students do at assigning ACLs to appropriate interfaces.  
 Max Value = 1      Earned Value = 0
- Scoring Rule For: Access List Definition Observable**  
 Measures how well students do at defining correct ACLs.  
 Max Value = 4      Earned Value = 0

At the bottom of the page, there is a "Close Window" button and a copyright notice: "All content copyright 1992-2002 Cisco Systems, Inc. [Privacy Statement](#) and [Trademarks](#)."

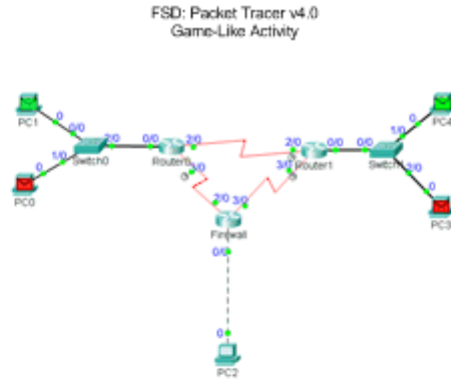
Figure 9: Packet Tracer’s Multiple Interactive Knowledge Representations, Including Logical Topology, IOS CLI, OSI Model View, Router State Table, and Animated “Packet Movie” Mode

The screenshot displays the Packet Tracer 3.2 interface with the following components:

- Simulation Mode:** A timeline at the top shows a packet being sent from PC0 to PC1. The time is set to 1.
- OSI Model View:** A vertical stack of layers from Layer 7 to Layer 1, with data being visualized at each level.
- Routing Table for Router 1:**

Type	Network	Port	Next Hop IP	Metric
C	1.0.0.0/8	1/0	--	0/0
C	10.0.0.0/8	0/0	--	0/0
R	11.0.0.0/8	1/0	1.1.1.2	120/1
- Edit Router 0:** Shows the IOS CLI configuration for Router 0, including OSPF settings and interface configurations.
- Network Description:** A text box explaining that the network is a simple routed network with various representations (logical topology, physical link status, CLI, OSI model, routing table, and animated packet).

Figure 10: Packet Tracer Activity and a Possible Finite State Diagram (FSD) Authoring of an Instructional Activity



Example Activity: Create access-lists on "Firewall" to allow the green packets to pass to PC2 and the red packets to drop.

