THE MIND PROJECT:
ROBOTICS
EVALUATION REPORT

Compiled By: Katie White Walters and Camellia Sanford

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COMPILED BY: KATIE WHITE WALTERS AND CAMELLIA SANFORD

PROJECT DESCRIPTION

The Mind Robotics curriculum is comprised of a set of online virtual labs whose purpose is to teach high school students the ways in which different kinds of robots can be programmed to carry out certain tasks. The curriculum has three main sections: An introduction to robotics and types of robots, a virtual Top-Down robotics lab in which students learn how to program a robot to recycle a soda can, and two Bottom-Up virtual labs in which students try to figure out how to create behavior hierarchies that result in robots either successfully navigating a hospital hallway or an obstacle course. An overarching theme of the virtual labs is the ways in which programmable robots are similar to or different than the human brain. The Robotics virtual labs are part of a larger effort, The Mind Project, led by David Anderson at Illinois State University. The Mind Robotics curriculum is funded in part through an NIH Science Education Partnership Award (SEPA).

Rockman et al, an independent research and evaluation company based out of San Francisco, serves as the external summative evaluator for this project. The purpose of the summative evaluation is to determine the impact of the Mind Robotics curriculum on students as well as to provide a descriptive study of its implementation by teachers.

METHODS

Rockman et al (REA) collaborated with the principal investigator to design a set of student surveys that could be used to assess changes in students’ interest in, knowledge about and confidence around robotics’ topics and activities (see Appendix A for instruments). REA also designed a teacher post-survey to collect information about who was using the curriculum, how and to what extent they were using it, and to gather teachers’ opinions regarding the benefits and challenges of implementing an online robotics interactive in their classrooms.
To recruit for the study, the principal investigator posted information about the project on
listservs and emailed past teacher contacts, asking them if they would be interested in
participating in a study of the Mind Robotics curriculum and guiding them to a sreener
survey for further information. Twenty-eight teachers responded to the sreener survey,
which included information about current class size, grade levels and subjects taught, and
the timeframe in which teachers would be able to participate in the study. Twelve of these
pre-screened teachers (all from Illinois) ultimately participated in the Mind Robotics
curriculum evaluation. These teachers were asked to collect parental permission slips from
their students, explore the Mind Robotics curriculum themselves, administer the online pre
and post student surveys, and implement the Mind Robotics curriculum in their classrooms
over a six-week period. Teachers were also asked to complete a post-survey outlining
their experiences with the curriculum. Teachers who returned their students’ permission slips,
had at least 80% of their students take both the pre and the post survey, and completed
a post survey themselves received a robotics kit from the principal investigator.

In addition, REA staff contacted one of the participating teachers to take part in a case
study of the implementation of the Mind Robotics module. As part of the case study, an
REA staff member went to this teacher’s school and observed several sessions in which the
teacher used the Mind Robotics module with his class. The staff member conducted focus
groups with several students in this class, as well as a more in-depth interview with the
case study teacher in order to gain better insight into how the Mind Robotics curriculum
functions in a classroom setting. The case study teacher received a $400 stipend for his
participation.

FINDINGS

Student Experience

Students who engaged with the Mind Robotics module showed a number of significant
knowledge, confidence, and interest gains related to robotics and technology (see
Appendix B for Table of pre-post data). Regardless of their previous Grade Point
Average or course in which the module was being used, students demonstrated significant
increases in their overall robotics’ knowledge as well as increases in their knowledge
about Top-Down and Bottom-Up robots. Students also reported having more confidence
in their robot-building skills, felt they had gained valuable experience in robot
programming, and had a greater interest in robotics-related topics overall. The magnitude
of these outcomes was influenced by factors such as prior technology or robotics’ interest,
prior experience or confidence in building robots, frequency of video game play, and
grade level in school.
Specifically, how students performed on the post content knowledge assessment was related to a number of other student characteristics. For example, students’ post assessment scores were significantly positively correlated with their pre assessment scores (i.e. what they knew about robots before the study). Post scores were also significantly positively correlated with students’ self-reported success in their science classes and current year in school. In addition, students’ experience building robots and how often they went online outside of school had a significant positive correlation with their post assessment scores (see Table 1).

Table 1: Pre-Survey Correlations with Post Survey Content Understanding*

<table>
<thead>
<tr>
<th></th>
<th>Positive Correlation to Post Content Assessment</th>
<th>Total N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test Assessment</td>
<td>.50</td>
<td>110</td>
</tr>
<tr>
<td>Past Science Class Success</td>
<td>.23</td>
<td>122</td>
</tr>
<tr>
<td>Grade Level</td>
<td>.48</td>
<td>133</td>
</tr>
<tr>
<td>Prior Experience Building Robots</td>
<td>.21</td>
<td>133</td>
</tr>
<tr>
<td>Online Experiences Outside of School</td>
<td>.18</td>
<td>132</td>
</tr>
</tbody>
</table>

*All correlations were significant at p<.05

As stated before, students made significant increases in several areas, but the size of those increases was mediated by the factors below.

**Interest in Technology**

Students who started out more interested in technology, also started out with and maintained a significantly higher level of self-reported robotics knowledge (p=.014) and confidence in their robot-building skills (p=.000) than those who were less interested in technology.

**Knowledge, Interest, and Experience in Robotics**

Despite maintaining scores below those with the highest levels, there was a general finding that students who started with the least confidence, experience, and interest in robotics made the largest self-reported and personal score gains.

For example, students with more robotics experience started out with a higher self-reported level of knowledge (Experienced Students’ Pre=5.68) and continued to increase their knowledge after participating in The Mind Project. Students with less experience made significant gains towards the knowledge level of the students who began at the highest point (Un-experienced Students’ Post=5.29). These differences were significant (p=.000). Students with less robotics experience also started out with and maintained a
lower level of confidence in their skills than their more experienced peers, although less experienced students showed larger increases in confidence than those who were already experienced (p=.000).

Students with a lower level of interest in robotics before the Lab showed greater confidence in their robot-building skills after the lab than their more interested peers (p=.000). Students with lower levels of interest to begin with also demonstrated higher learning gains than their more interested peers (p=.004).

Similarly, students with less confidence in their robot building skills made greater self-reported knowledge gains from pre to post than their more confident peers (p=.000).

**Experience Playing Video Games**

Those who do not often play video games made bigger leaps in their robot-building confidence from pre to post than their video game playing peers (p=.000). This result mirrors earlier findings related to larger gains being made by students who started out with the least robotics’ experience.

**Grade Level**

Students in all grade levels self-reported significant knowledge gains. However, paired comparisons indicated that 11th graders had significantly more gains than 9th (p=.009) or 10th graders (p=.002). Twelfth graders also had significantly greater gains than tenth graders (p=.027). In terms of actual learning gains, ninth graders had slightly lower increases in pre to post test learning than 11th (p=.000) or 12th graders (p=.000) did. This could be attributed to older students with more prior knowledge and experience or to the instruction level of the modules themselves.

**Student Sample Demographics**

The above analyses were drawn using data received from 366 students (i.e. those who submitted both a pre-test and a post-test). Based on the information students provided, it appears that most were in 11th or 12th grade (see Table 2). Students (N=212) mean Grade Point Average was 3.28 on a Four-point scale.

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Number of Students</th>
<th>Percentage of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>71</td>
<td>19%</td>
</tr>
<tr>
<td>10</td>
<td>22</td>
<td>6%</td>
</tr>
<tr>
<td>11</td>
<td>83</td>
<td>23%</td>
</tr>
<tr>
<td>12</td>
<td>97</td>
<td>27%</td>
</tr>
<tr>
<td>Grade Level Not Listed</td>
<td>93</td>
<td>25%</td>
</tr>
</tbody>
</table>
Though science was only 20% of students’ favorite course, most participants liked learning about science (79%, N=272) and felt that they did well in their science classes (89%, N=238). Even more so, students liked learning about technology (89%, N=275), felt they were good at using technology (92%, N=274), and felt that they performed well in their technology classes (96%, N=198).

Most students indicated that they use computers daily or several times a day during school (70%, N=274). Students also went online frequently, either daily or several times a day, outside of school (83%, N=274). Several students were also daily video game players (36%, N=275), and most others played video games at least “sometimes” (53%, N=275). However, students rarely, if ever, played online educational games at home (79% indicated that they never or rarely played educational online games at home, N=274). Regardless, about half the students indicated that they liked playing online educational games, in general (N=254).

**Teacher Experience**

**Implementation of the Mind Robotics Curriculum**

Half of the educators using the Mind Robotics curriculum had taught robotics before. For the other half, it was their first time teaching any kind of robotics curriculum. Of those who had taught such a course before, most (67%) had taught robotics in one to four classes. Regardless of whether they had taught a robotics course before, participating teachers felt that they had slightly below average knowledge of robotics topics (Mean of 4.67 on a scale of 1 to 10, one being no knowledge and 10 being expert knowledge).

Most teachers implemented the Mind Robotics curriculum in an Electronics, Technology, Industrial Arts, or Engineering course. Only one teacher implemented the Mind Robotics curriculum in a science course (Physics). Teachers indicated that most students who used the Mind Robotics curriculum were between 15-18 years of age. Regardless of age, teachers felt that the Mind Robotics curriculum had been at an appropriate level for their students (i.e. no educator thought that the overall curriculum was too easy or too hard).

Most teachers gave students the Mind Robotics curriculum individually in a computer lab, a configuration likely influenced by the school’s available resources (see Table 3). For the majority of teachers (83%), the Mind Robotics curriculum was a stand-alone activity (although later comments seemed to indicate that teachers easily tied the Mind Robotics
experience to subsequent robot encounters). A few teachers used the Mind Robotics curriculum as an introduction to a new topic (17%) or as an activity as part of a unit (8%).

Table 3: Method in Which the Mind Robotics Curriculum Was Implemented*

<table>
<thead>
<tr>
<th>Method of Implementation</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individually (in a computer lab)</td>
<td>12</td>
<td>100%</td>
</tr>
<tr>
<td>Pairs (in a computer lab)</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>Groups of 3 or more</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>Project the lab on screen in front to entire class</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Individually (at home on their own time)</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Some teachers used more than one method

All teachers completed the Top-Down and Bottom-Up Virtual Robotics Labs with their students. However, there were some variations to how the Mind Robotics curriculum was implemented. Some teachers read Mind Robotics text aloud because their students had lower literacy levels. Other teachers developed module outlines with guiding questions to help students retain information. One teacher even created an elaborate activity and changed around the order of some of the lab content to encourage students to review information. This teacher and others discussed changing the order of activities to do Top-Down then Bottom-Up because the Bottom-Up is more complex.

On average, it took teachers 3.75 hours to prepare for the modules (Range = 0 to 8 hours). In the classroom, it took an average of 1.46 hours to complete the Introduction to Robotics section (Range = 30 minutes to 2 hours), 2.77 hours to complete the Top-Down Virtual Lab (Range = 1 to 4 hours), 1.42 hours to complete the Bottom-Up Hospital Task (Range = 30 minutes to 3 hours), and 1.35 hours to complete the Bottom-Up Ethology Task (Range 30 minutes to 2 hours and 15 minutes). Teachers also spent an average of 1.25 hours (Range = 0 to 6 hours) on supplemental activities and 1.10 hours completing a wrap-up discussion on the topic (Range = 0 to 2 hours). One teacher noted that it was difficult to know how long each module should take for students.

Teachers had a variety of ways that they graded student participation in the Mind Robotics curriculum (see Table 4). Most teachers graded students’ work, gave them a grade for completing the curriculum as a whole, or relied on post-test or online quiz scores.
Table 4: Methods for Grading the Mind Robotics Curriculum

<table>
<thead>
<tr>
<th>Points System</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No points</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Completion grade</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Grade for work</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Online quiz score</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Additional project</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>Extra credit</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Post-test score</td>
<td>2</td>
<td>17%</td>
</tr>
</tbody>
</table>

**Mind Robotics Curricular Connections**

Regardless of how the module was implemented, all participating teachers felt that the module had fit in with their classroom curriculum. For example, some teachers used the Mind Robotics curriculum to supplement other robotics resources they had used in the past:

*I typically teach Intro to Robotic Engineering using LEGO Mindstorms and the Virtual Robotics Lab was a great introduction to robotics and robotic engineering.*

*As follow up to the virtual module, we have already begun to explore robotics through Parallax’s Sumobot and Boebot kits, which I feel the virtual lab adequately prepared us for.*

Others felt that the lab met specific state technology standards such as fostering critical thinking, problem solving, decision-making, and aspects of the design process:

*I felt like it met many Illinois State Standards that I normally have a tough time covering. These talk about design aspects and whether the design is as good as it can be. These targets ask students to review designs and change them to make it better. The virtual lab allowed me to do this in a cost effective and up-to-date manner.*

Some teachers also used the Mind Robotics curriculum to review specific content:

*My Introduction to Technology class is studying Communication Technology, specifically Information and Electronic Communication. The Virtual Robotics Lab*
covered binary code, communication modes, programming, sensors, and much more. The lab was an obvious fit for my Electronics class due that which was stated above, plus DC servo motors, power regulation, trouble shooting, and problem solving.

**Teachers’ Opinions of the Mind Robotics Curriculum**

Overall, most teachers (67%) felt that the Mind Robotics curriculum had been very useful. Almost all (83%) thought that there was “a very good chance” that they would work with similar activities in the future. All teachers (100%) were also “likely” or “very likely” to recommend the Mind Robotics curriculum to other teachers.

Teachers liked the multimedia and interactive aspects of the modules, the presence of real-world robot examples, the modules’ overall ease of use, and the depth and flexibility of the content provided. Several teachers also felt that the lab was enjoyable and had motivated students to learn:

> The problem-based approach forces students to think and solve problems. A lot of times if a student can’t figure something out on the first try, they quit. They do not demonstrate this behavior at home on video games, however. Providing an interactive multimedia format allows students to try things until they get the solution, much like the world works and the video games they love.

For specific areas of the curriculum, individual teachers mentioned the building and programming of IRIS, the Top-Down section, and the robot videos as popular with their students. Teachers also found the Teacher Page and tips to be helpful:

> The Teacher Page was very helpful and contained all needed information. In conjunction with actually working through the module myself, I felt well prepared to assist my students.

**Bottom-Up Virtual Lab**

Many teachers felt that Bottom-Up Virtual Lab had gone well, in general. Teachers liked that the Bottom-Up Lab was “brief” and encouraged students to “think outside the box and apply higher level thinking skills.” One teacher appreciated that the Lab had two levels of difficulty. In particular, teachers identified the hospital task as challenging, but rewarding for students:

> With the Hospital, I think that students really struggled with deciding which action was most important and it made them really analyze and try and retry what worked - This was good for them.
Teachers also liked the examples given, such as the moth hierarchy, to explain the complex information. They identified biology and computer programming as potential areas to expand conversations around hierarchies with their students.

There were some aspects of the Bottom-Up Virtual Lab that teachers did not like. Several felt that the content and reading assignments were not as engaging for their students, and that those tasks lost students’ interest or could become frustrating. Several teachers suggested replacing the long, written passages by either breaking up the reading into smaller chunks, substituting written text with instructional videos, or teaching the information to the class themselves. A few teachers had trouble navigating the Bottom-Up section. Specifically, one teacher indicated that he had had trouble loading the Ethology videos. Another teacher had difficulty locating the Help Page. Teachers also indicated that some students did not understand the goal of the activity:

*The target task was difficult for students to understand. They kept saying, "What is the point?" I told them they needed to mirror the action of the robot. That needed to be a little clearer.*

**Top-Down Virtual Lab**

Teachers liked that the Top-Down Lab was engaging, interactive, visually appealing, and well-designed:

*Students really engaged in the portion of the lab of writing script and seeing the robot complete the task they had told it to complete. They were discouraged at times in trying to write script, but once complete were elated with their accomplishments.*

One teacher also noted that it was important for students “to see how programming is done now instead of 1 & 0.”

In particular, teachers liked the videos, programming the robot, and the linear nature of the Lab:

*The math and science links in determining the timing of the motion was a real plus. Building the arm and programming it were engaging, and the task list helped me in telling students what to do next.*

*I liked that the students could not move on until they had finished the task they were given. It helped to keep them focused and prevent them from skipping ahead. It was easy to navigate and gave them just enough hints and help to keep them going independently.*
They also felt that their students had most enjoyed “seeing how the robot responded to commands” and “watching IRIS complete the task after they had written the script and built the parts.” Alternatively, students became frustrated if they could not get the robot to move or if the program was running slowly. One teacher and some students felt that the task of placing the robot parts on the stand was too easy for students.

Some teachers thought that the Top-Down activity was too short and wanted greater complexity, but also felt that the amount of reading was too long and overwhelming for students:

> Once again, my students resist reading like it’s the plague. They even frequently skipped reading the pop-up windows that appeared after successfully completing a lab task, which left them confused and lacking crucial information.

Several teachers mentioned that the navigation “was not intuitive” and that some of the online links to the activity did not work:

> We kept at it, but many times it was hard to find the right link to get them to the right place.

> Due to the in-depth nature of the labs and the countless opportunities to explore with embedded links on every page, it became confusing as to where in the module you actually were and how to get back where you needed to be. Though the students were informed that the "Back" button would be their most powerful navigational tool, they still got lost easily.

Teachers had several suggestions for extending the Top-Down activity. Several teachers wanted to work with their students to program a real IRIS robot or robotic arm. One teacher suggested, “flow charting what the robot does” to help students better understand programming concepts.

**Challenges to Implementation of Online Modules**

Teachers identified a range of challenges related to implementing online modules, in general, at their schools. For example, many schools did not have the technology infrastructure or online access to support online modules:

> Technology is always challenging and with our very tight security and student access, things don’t always work well. Sometimes videos do not load or students do not have access to certain websites.

> We also had a few videos blocked by our district filter; I got around that by playing them on the overhead for everyone.
Other teachers cited the cost of computers and associated technologies as well as the number and age of computer resources, which run slowly and require updates or the presence of certain programs to function, as barriers.

**Teacher Sample Demographics**

Twelve Illinois high school teachers, including the case study teacher, used the Mind Robotics curriculum in their classrooms and participated in this study. All the teachers were veteran teachers and majority had been teaching for ten or more years.

All educators (N=12) had computer labs at their schools with one computer per student available, while a few teachers (N=2) also had computers in their classrooms. As to other technologies available, almost all of the teachers in the sample had digital cameras (see Table 5). Many also had access to scanners, software packages associated with students' textbooks, and other software packages such as Autodesk, AutoCAD, Adobe Illustrator, PageMaker, and Google Sketch Up.

**Table 5: Types of Technologies Available for Classroom Use (N=12)**

<table>
<thead>
<tr>
<th>Type of Technology</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital camera</td>
<td>10</td>
<td>83%</td>
</tr>
<tr>
<td>Scanner</td>
<td>8</td>
<td>67%</td>
</tr>
<tr>
<td>Digital microscope</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>Software packages (associated with textbook companies)</td>
<td>8</td>
<td>67%</td>
</tr>
<tr>
<td>Software packages (other - list)</td>
<td>8</td>
<td>67%</td>
</tr>
<tr>
<td>Online programs (list)</td>
<td>2</td>
<td>17%</td>
</tr>
</tbody>
</table>

*Some educators gave more than one answer

Most participating educators (83%) indicated that they used technology as a teaching tool on an almost daily basis. The rest (17%) used technology in the classroom on a weekly basis. In school, all of the participating teachers allowed their students to use search engines like Google or Yahoo. Two teachers responded that they used social networking and instant messaging or blogging and social bookmarking in their respective classrooms. Though used less frequently in the classroom, teachers personally participated in many of these online activities. All teachers reported personally using search engines (83%), Social Media (58%) and 50% use conferencing and Wiki respectively. The fewest reported using Social Bookmarking at 17%.
Most teachers allowed their students to engage with a range of computer and online games in class (see Table 6). But again, the teachers personally engaged with a wider range of games outside of work than they did at school.

Table 6: Types of Games Educators Allow Their Students To Use In School with Types of Games Educators Personally Use*

<table>
<thead>
<tr>
<th>Types of Games</th>
<th>Student Classroom Use</th>
<th>Personally Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Response</td>
<td>%</td>
</tr>
<tr>
<td>Computer games that came free with the computer (Solitare, Mindsweep)</td>
<td>3</td>
<td>25%</td>
</tr>
<tr>
<td>Free online video games for the computer</td>
<td>7</td>
<td>58%</td>
</tr>
<tr>
<td>Purchased video games for the computer</td>
<td>2</td>
<td>17%</td>
</tr>
<tr>
<td>Free games that came with cell phone/pda/smart phone</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Game apps that download to cell phone/pda/smart phone</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Handheld game systems (psp, DS, Gameboy)</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Games played on a video game system (PlayStation, Xbox)</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>None</td>
<td>4</td>
<td>33%</td>
</tr>
</tbody>
</table>

*Some teachers listed more than one game type

In general, participating teachers (75%) preferred to learn new information through hands-on activities. One teacher each preferred learning by looking something up online, asking other people, or doing a virtual or online activity to learn new information.

When asked specifically about online learning, many teachers (50%) personally liked using virtual game experiences to learn about new educational topics. Only one teacher ruled out personally learning through virtual games completely. The rest (42%) indicated that it would depend on the game and/or topic.
CASE STUDY OF ROBOTICS CURRICULUM IMPLEMENTATION

During the week of November 7th, Rockman et al staff observed one teacher, in rural central Illinois, implement the Comprehensive Robotics Module with two classes of high school students. One class was Introduction to Technology with 17 students (Class A) and the other was a Basic Electronics course with 10 students (Class B). The classes were comprised predominantly of white males, ranging in age from 15-19. Most students were in 10th or 12th grade.

Classroom Observation

Before the observation, students had been given a brief explanation of the lab, submitted parent permission slips, and taken the evaluation pre-survey. In both classes, the students appeared to value the time they got to spend on computer-based activities, in general. The teacher began Class A by looking at and discussing several of the Robotics: Kinds of Robots videos together on the class Smart Board. During this introduction, the students seemed to be eager to get on the computers themselves and navigate the site. The teacher noted this enthusiasm and cut short his presentation, ending with a quick navigation tutorial for entering the lab and moving through tasks.

During Class B the teacher cut short much of his introduction and allowed students to work through the introduction on their own. Both strategies had positives and negatives: Students in Class A were not immediately engaged but had a better idea of the program when they began, while Class B was immediately excited yet struggled with some of the lab’s more basic navigation. In both classes, the students rushed to the computers after the introduction. Many were able to get into the labs immediately, but several had general trouble with following the directions or navigating to the page.

Students, in both classes, did not appear to spend the time necessary to read through the entire Introduction to Robotics section, but did watch many of the videos included in the introduction. Students were allowed to engage in conversation while they worked, so “wow, look at this” and “where did you find that?” echoes scattered throughout the room as students watched the videos. The exoskeleton and prosthetics videos gained the most attention and some students watched them multiple times. During the student focus group session at the end of the labs, many of the students brought up those videos as intriguing new material and topics they would want to learn more about. After getting excited about the types of robots, many students just quickly skimmed the section on Parts of a Robot, in order to get to the Top-Down lab. Students in Class B seemed to move more quickly to the virtual lab, either because word of mouth had let them know that was the more hands-on piece or because they were older and more inclined to skip sections.
To complete the Top-Down lab, students in Class A used the flexible version without signing in, while students in Class B signed in using the basic version. Students in both versions whizzed through the instructions and appeared to feel their way around in the lab until they reached an area with a task. However, this was not true for everyone: Some students diligently read the instructions and navigated through the lab with ease. Most students completed the tasks in the expected order (lab overview, reading material, and wheel control), but some students jumped straight into the arm builder station, as it was the first visible activity in the lab. Many students tried to do activities out of order, but they ran into dead ends and had to return to the tasks’ objectives lists. This led to frustration in some students who were annoyed that they couldn’t do what they wanted. Of the individual pieces, students seemed most engaged with the arm builder and the wheel scripter, frequently discussing these pieces during the focus groups. Most students in both classes finished the individual pieces of the Top-Down robot during the first session, but did not have time to complete the entire lab in a fifty-minute class period.

Students in Class A, switched versions to sign into the basic version during their next class and the teacher instructed them to rebuild the arm and reprogram the wheels, as practice. The teacher explained that if students didn’t finish that day during class, he wanted them to be able to save their work. Some students seemed frustrated by this change, but many appreciated that they could use what they had learned during the prior class. Students were quickly able to build the arm and program the scripter during their second attempt. In Class B, students moved directly into programming the full robot and some were quickly ready for the next lab. While programming arm script, many students were frustrated because they were unable to save their work or didn’t understand why their script did not work. Some also struggled with combining the scripts, when they had not saved or named the file properly or did not read the instructions entirely. All students were eventually successful, but this was the point when most students needed help from the teacher. Students seemed excited when the got the entire robot to work, but most of the verbal exclamations followed students’ in programming one of the individual units; There were shouts of “I got it” or “look at it go.”

Students in both classes stopped working when they finished the Classic Top-down Robotics Lab and continued the following day with the Behavior-Based Bottom Up Robotics Labs. Students worked on the Hospital Task first and seemed very interested in the videos describing robots used in hospitals. Many students found the instructions in the Hospital Lab difficult to follow and were unsure if they had completed the task.

Students did not seem to read the information included on robot hierarchies, but did appear to engage with the chart on the same page. The students were observed using trial and error to complete the Hospital and Ethology Task. During the focus groups, some
students mentioned that they would have liked more guidance in the tasks involving the subsumption hierarchy. Students enjoyed watching the Ethology Task robot complete their assigned hierarchy and generally continued to explore even after they found the correct order, “just to see what it [would] do.”

**Student and Teacher Feedback**

Students reported really enjoying working on the virtual labs. Many explained that they never would have learned how robots are used in real life without the labs. The idea that robots were more than fantasy and that students likely regularly encounter them was foreign, but students were excited by their new base knowledge and inspired by all the possibilities. During the focus groups, students often mentioned the new types of robots encountered in the videos and discussed their desire to learn more about robotics.

The case study teacher was similarly excited by his students’ interest and engagement with the robotics module. He was already beginning to plan how to use the lab with other classes and in future years, explaining how he would roll other pieces of curriculum into the lab. He explained the benefits of the curriculum as follows: “They are walking away with so much new information that they don’t even know they know. It is so much reinforcement with math and science.” The idea that students were able to practice a real world application of their course work was really important to the case study teacher, as was the ability to “build” robots, which their school wouldn’t have had the individual resources or space to do otherwise.

Overall, the robotics curriculum was successfully implemented during the case study observations. Though this was the teacher’s first experience with the curriculum, he was able to structure it for his class and create a powerful learning experience using the Mind Virtual Robotics Labs. His students were open to and engaged with the curriculum. REA was also able to gather valuable information on students’ thoughts about robotics and the Mind curriculum during the focus group. Both during interviews and over the course of the class, the teacher was also able to share his struggles with implementation, thoughts for the future, and detail the placement of the labs within his curriculum. In sum, the modules worked very well in the classroom and students clearly learned a lot and had a unique experience with robotics content and activities.
SUGGESTIONS FOR IMPROVEMENT

Participating teachers had several suggestions for improving the Mind Robotics curriculum and activities:

Navigation

- Teachers suggested creating an easy navigation page with tabs for the Labs that can be reached via a simple URL.
- Daily log-in was a challenge for students. With some unable to log-in at different times and others struggling with complicated passwords. One teacher wished for more instruction on the log-in process.

General

- Some teachers hoped for an overview they could work through with students.
  - I would explain the targets of each lab in more detail before getting started. I would show them both labs on my Promethean Board instead of letting them dive right in so they knew how to navigate it better.
- Teachers wanted the “answers” to all of the labs to reference when students asked for help.
  - The answers to all of the labs need to be on a simple Word document that can be printed.
- Teachers wanted a clear mode of embedded assessment during the lab.
  - Including quizzes for each reading section: It would be nice to measure the level of the students learning on a section by section completion like quizzes. Such as, history, types, etc. Computerized grading would be great as well.

Top-Down Virtual Lab

- Many teachers mentioned that students struggled with saving and completing tasks in the Basic Version.
  - For example: One student must have saved his wheel script for IRIS wrong and then when he was trying to combine the wheel and arm scripts there was nothing there - It also would not show the direction from that part, so he needed me to write the script for him or he would not have been able to complete the module.
• Teachers suggested adding images or video to supplement or take place of some of the readings.

• Teachers also wanted the program to provide hints to students after a failed attempt at an activity.

• During the IRIS assembly, some teachers wanted the program to point out necessary and unnecessary parts of a robot in more detail.

• Teachers wanted a reduction in the amount of reading.
  o They were so long that it overwhelmed the students. I think that they should be shortened or make two versions of the lab. One that was a shorter, more precise version and one that is longer.

Bottom-Up Virtual Lab

• Teachers wanted more student guidance during the hospital task through changes in programming or hints.
  o I thought it would be more interesting if you put landmarks on the hospital task (like a painting on the wall or a vase). Then students would know if they were heading the right way a little easier.

• Teachers also sought more explanation for and positive reinforcement of the correct answers.
  o I wish when the kids got done with the lab, there was another page that would pop up that would go over all of the possibilities for the hierarchies and why they all worked.
  o I think that a bit more celebration/recognition for successfully completing a lab would be good.

• Teachers felt that the Lab would benefit from the inclusion of more examples and clear description of types of real-world Robotics use.
  o I would like to have seen more real examples of the present and future usefulness of Bottom-Up robots besides the hospital videos.
CONCLUSION

Overall, the Mind Robotics curriculum was well received by teachers and their students. Despite some navigational issues and a general desire for a reduction in the amount of reading, students experienced positive benefits from their participation. In particular, students saw increases in their level of confidence in building robots, interest in the topic of robotics, and strong knowledge and learning gains related to the curriculum’s robotics content. Teachers also enjoyed the curriculum and were able to tie the virtual labs in with their existing instruction, both as an additional robotics resource and as a tool for fostering students’ problem-solving, design process, and higher-order thinking skills.
APPENDIX A: DATA COLLECTION INSTRUMENTS

MIND ROBOTICS POST - Student

Now that you’ve completed the Comprehensive Robotics Module, we want to know a little bit about what you thought of the program. Please answer the questions below as honestly as possible. Your name will be used to link your survey responses before and after you participate in the Mind Virtual Lab together. After that, your name will not be used for any analysis or reporting. We will replace your name with an anonymous ID number. If you have any questions, please ask your teacher. Thanks for your help!

Your Name:

First Name ______________________________________________
Last Name ______________________________________________

Your School:

- Casey-Westfield High School
- Central High School
- Champaign Central HS
- Eureka High School
- Farmington Central High School
- Jacksonville High School
- Jersey Community High School
- Joliet West High School
- Lawrenceville High School
- Lemont High School
- Lyons Township High School
- Marshall High School
- Minooka Community High School
- Momence High School
- Neoga Jr. Sr. High School
- Okaw Area Center
- Okawville Jr Sr High School
- Our Lady of Grace School
- Paxton Buckley Loda High School
- Percy L. Julian
- Prosser Career Academy
- Rockford Jefferson High School
- Roosevelt Alternative High School
- Roxana High School
- Salem Community High School
- Steinmetz AC
- Taft High School
- Triad High School
- York Community High School
- Other:
Your State:

<table>
<thead>
<tr>
<th>Alabama</th>
<th>Iowa</th>
<th>Nevada</th>
<th>South Dakota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>Kansas</td>
<td>New Hampshire</td>
<td>Tennessee</td>
</tr>
<tr>
<td>Arkansas</td>
<td>Kentucky</td>
<td>New Jersey</td>
<td>Texas</td>
</tr>
<tr>
<td>California</td>
<td>Louisiana</td>
<td>New Mexico</td>
<td>Utah</td>
</tr>
<tr>
<td>Colorado</td>
<td>Maine</td>
<td>New York</td>
<td>Vermont</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Maryland</td>
<td>North Carolina</td>
<td>Virginia</td>
</tr>
<tr>
<td>Delaware</td>
<td>Massachusetts</td>
<td>North Dakota</td>
<td>Washington</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>Michigan</td>
<td>Ohio</td>
<td>West Virginia</td>
</tr>
<tr>
<td>Florida</td>
<td>Minnesota</td>
<td>Oklahoma</td>
<td>Wisconsin</td>
</tr>
<tr>
<td>Georgia</td>
<td>Mississippi</td>
<td>Oregon</td>
<td>Wyoming</td>
</tr>
<tr>
<td>Idaho</td>
<td>Missouri</td>
<td>Pennsylvania</td>
<td>Puerto Rico</td>
</tr>
<tr>
<td>Illinois</td>
<td>Montana</td>
<td>Rhode Island</td>
<td>Alaska</td>
</tr>
<tr>
<td>Indiana</td>
<td>Nebraska</td>
<td>South Carolina</td>
<td>Hawaii</td>
</tr>
<tr>
<td>I do not reside in the United States</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Name of your Teacher in this course: ____________________________________________

What grade level are you currently in?

<table>
<thead>
<tr>
<th>Below 6th</th>
<th>6th</th>
<th>7th</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
<th>11th</th>
<th>12th</th>
<th>College</th>
</tr>
</thead>
</table>

Answer Either A or B.A. What is your approximate Grade Point Average on a 4 point scale?

______ Four Point Scale

B. What is your approximate Grade Point Average on a 5 point scale?

______ Four Point Scale
What is your favorite subject in school?

- English/Language Arts
- Math
- Science
- History
- Art/Music/Dance/Theatre
- Foreign Language
- Other

Do you like learning about science, in general?

- Yes
- No

Do you do well in your science class?

- Yes
- No
- I am not currently taking a science class.

Do you like learning about technology?

- Yes
- No

Do you feel like you are good at using technology?

- Yes
- No

Do you do well in your technology class?

- Yes
- No
- I am not currently taking a technology class.
How often do you use a computer during school?

○ Several times daily
○ Daily
○ Weekly
○ Monthly
○ Rarely
○ Never

Do you like playing online educational games?

○ Yes
○ No
○ I’ve never played an online educational game.

How often do you play online educational games at home?

○ Several times daily
○ Daily
○ Weekly
○ Monthly
○ Rarely
○ Never

How often do you go online outside of school?

○ Several times daily
○ Daily
○ Weekly
○ Monthly
○ Rarely
○ Never
What do you do online? [Check all that apply.]

- Search Engine (Google, Yahoo)
- Social networking (Google+, Facebook)
- Chat/instant messaging (AIM, iChat)
- Blogging/micro-blogging (Blogspot, Blogger, Twitter)
- Online Audio Conferencing (Skype, GTalk, Gizmo)
- Social Bookmarking (Delicious, Pinterest, Digg)
- Wiki (Wikispaces, PBWiki)

How often do you play video games?

- Never
- Sometimes
- Daily

How do you prefer to learn new information?

- Read it in a book
- Look it up online
- Ask someone
- Do a hands-on activity
- Do a virtual/online activity
- Other ____________________

Robotics

What is your level of interest in learning about robots and how they work?

- Not interested
- Somewhat interested
- Interested
- Very interested
What is your level of knowledge about robots on a scale of 1 to 10, with 1 being "No knowledge" and 10 being "Expert"?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

Do you have experience building robots?

- Yes
- No

Please describe your experience building robots.

How confident are you in your robotics skills?

- Not at all confident
- Somewhat confident
- Confident
- Very confident

How much new information did you learn from the Virtual Robotics Labs?

- No new information
- Very little new information
- A large amount
- A very large amount

Now, we will ask you some questions about robots and how they work.
Match the type of robot with its definition by placing the type under the definition.

<table>
<thead>
<tr>
<th>Pre-programmed robots</th>
<th>Autonomous robots</th>
<th>Teleoperated robots</th>
<th>Augmented robots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gives a person a missing capability or enhances an existing ability</td>
<td>Controlled remotely by humans</td>
<td>Robots that have to be told what to do ahead of time</td>
<td>Detects changes in the environment and adapts to them</td>
</tr>
<tr>
<td>Gives a person a missing capability or enhances an existing ability</td>
<td>Controlled remotely by humans</td>
<td>Robots that have to be told what to do ahead of time</td>
<td>Detects changes in the environment and adapts to them</td>
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</tr>
<tr>
<td>Gives a person a missing capability or enhances an existing ability</td>
<td>Controlled remotely by humans</td>
<td>Robots that have to be told what to do ahead of time</td>
<td>Detects changes in the environment and adapts to them</td>
</tr>
</tbody>
</table>

This camera is an example of what part of a robot?
- Motor
- Effector
- Motherboard
- Sensor
- Relay

This gripper arm is an example of what part of a robot?
- Motor
- Effector
- Motherboard
- Sensor
- Relay
Drag the statements and pictures that describe each type of robot into the columns below (Note: Some answer choices may fit into both columns).

<table>
<thead>
<tr>
<th>Top Down Robot</th>
<th>Bottom Up Robot</th>
</tr>
</thead>
<tbody>
<tr>
<td>______ Has a “brain”</td>
<td>______ Has a “brain”</td>
</tr>
<tr>
<td>______ Uses Scripter</td>
<td>______ Uses Scripter</td>
</tr>
<tr>
<td>______ Uses subsumption architecture</td>
<td>______ Uses subsumption architecture</td>
</tr>
<tr>
<td>______ Image:Robot1a</td>
<td>______ Image:Robot1a</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Is human intelligence a function of top-down mechanisms, bottom-up mechanisms or some combination of the two? Give reasons for your answer.

Which Virtual Robotics Lab did you complete? (select all that apply)

- Top-Down Robotics Lab (recycling a can task)
- Bottom-Up Robotics Lab (hospital task)

Bottom-Up Robotics Lab Questions

Which of the following most accurately describes a “bottom-up” or behavior-based robot?

- It has a brain or artificial intelligence program that controls its behaviors
- It uses a pre-determined order of simple behaviors that make the robot appear to be “thinking”
- It has a series of complex behaviors programmed into its software
- It does not respond to environmental stimuli
- None of the above
What is the primary purpose of creating a behavior hierarchy for a “bottom-up” robot?

- To assure that all behaviors operate equally.
- To organize priorities among competing behaviors.
- To assure that some behaviors always occur, while others never occur.
- To assist the robot in planning for its next move.

When a Bottom-Up robot has conflicting goals, how does it decide which goals win out?

The figure below illustrates a simple behavior hierarchy found in moths:

Based on this hierarchy, which of the following is the best prediction of how a moth will behave?

- If bats are detected, the moth will fly away, even if mates and food are available.
- Finding food will always take priority over other behaviors.
- Moths would rather find food than seek mates.
- The moth could decide to either find food or avoid bats, if mates are not available.

The figure below illustrates a simple behavior hierarchy for a behavior-based moving robot:

Choose the statement that best represents a logical description for “X” in the figure above:

- “Avoid” always suppresses “Escape.”
- “Avoid” suppresses both “Escape” and “Cruise Forward.”
- “Escape” suppresses “Avoid” when the robot is in danger of getting stuck.
- The robot will probably never activate its “Escape” mechanism.

A simple robot behavior hierarchy is shown in the figure below.

Analyze the hierarchy. Why won’t this hierarchy work?

- Cruise is suppressed, so the robot will not move.
- Seek light is the highest priority, so if the robot runs into something it will get stuck.
- Avoid is suppressed, so the robot will constantly run into things.
- Follow Wall is not the highest priority, so the robot will never follow the wall.

Construct a behavior hierarchy for a factory robot that will deliver tools to a specified work area. Drag the behaviors on the left to the right side. Place them in the proper order from top to bottom so that the
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robot will find the correct work area (marked with “work area sensors” or WAS tags) and will not get lost or stuck along the way.

______ Enter Work Area
______ Follow Wall
______ Escape
______ Found WAS tag
______ Cruise Forward

Explain how you decided where to place each behavior.

Top-Down Robotics Lab Questions

Which of the following best describes a “top-down” robot such as Iris.4?

- It responds to various stimuli from the environment in simple ways, much like “reflex” reactions.
- It is controlled by a master “brain,” which is actually an artificial intelligence program that tells the robot parts what to do.
- It uses a hierarchy, or pre-determined order, of simple behaviors that make the robot appear to be “thinking.”
- None of these describes a “top-down” robot.
Match the following robot hardware parts with their functions by selecting the part in the dropdown next to its function.

<table>
<thead>
<tr>
<th>Stores computerized data</th>
<th>Runs software, including the Mind Module</th>
<th>Power supply</th>
<th>Allows the robot to “talk” to people</th>
<th>Allows the robot to move from place to place</th>
<th>Allows the robot to “hear”</th>
<th>Changes power from direct to alternating current</th>
<th>Allows the robot to “see”</th>
<th>Communicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>○</td>
<td>○</td>
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<td>○</td>
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</tr>
</tbody>
</table>
In the lab, you used a “scripter” program to tell the robot how to move its wheels. Each square in the pictures represents 1 second; gray squares are “on”; white squares are “off”; for each diagram, top row is left wheel, bottom row is right wheel. Which pattern below will tell the robot to: move forward 3 seconds, turn left, move forward 2 seconds, turn right, move forward 3 seconds, and stop?

- [ ] A
- [ ] B
- [ ] C
- [ ] D
Using the blank diagram below, design a wheel program that will tell the robot to do the following steps. (Using checking for “on” and leave blank for “off.”)

- Move forward 5 seconds.
- Turn right 2 seconds.
- Move forward 4 seconds.
- Turn right 1 second.
- Move forward 4 seconds.
- Turn left 2 seconds.
- Move forward 3 seconds.
- Stop.

<table>
<thead>
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<tbody>
<tr>
<td>Left</td>
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</tbody>
</table>

Refer to the screen clipping for the next two questions.
The screen shows the layout of the arm scripter program. Which area is used for each function below?

<table>
<thead>
<tr>
<th>Function</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keeping track of saved computer commands for the gripper arm</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Starting a preview of the entire gripper arm action sequence</td>
<td></td>
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</tr>
<tr>
<td>Creating commands for the gripper arm</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Saving the entire gripper arm program in a file once it is complete</td>
<td></td>
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</tr>
<tr>
<td>Watching the actions of the gripper arm as you create the program and as you preview it</td>
<td></td>
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</tr>
</tbody>
</table>

Compare the processes you used to program commands for the wheels and for the gripper arm. How are they similar (at least 3 ways)?

Compare the processes you used to program commands for the wheels and for the gripper arm. How are they different (at least 2 ways)?
From the dropdown list, choose the software component that fits each software function below:

<table>
<thead>
<tr>
<th>Function</th>
<th>Speech-to-Text Engine</th>
<th>Servo Controller Interface</th>
<th>Camera Interface</th>
<th>Flash ProtoThinker</th>
<th>Image Processor</th>
<th>Central Control Program</th>
<th>Mind Module</th>
<th>Text-to-Speech Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>An artificially intelligent agent that can communicate in human language and perform logical reasoning</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allows all other software modules to communicate with each other</td>
<td>│</td>
<td>│</td>
<td>│</td>
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<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can allow, block, alter, or delete messages from other programs</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides Iris.4 with a “voice”</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allows Iris.4 to “hear” spoken language</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicates scripts that control the robot’s wheels and arms</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allows Iris.4 to “see” via digital images that can be transmitted to other software</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td>│</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>modules</td>
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</tr>
<tr>
<td>Interprets digital images</td>
<td>o</td>
<td>o</td>
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</tr>
</tbody>
</table>

In the lab, you programmed the robot to recycle empty soda bottles. What is another useful task this type of robot (with wheels and gripper arms) could perform?

One theory on the human brain is that it is one large information-processing system that does everything. Another theory, the “modularity hypothesis”, says that the human brain is composed of different modules, each with its own special function. Is the Iris.4 robot modular in this way? Explain why or why not.
The Mind Project: Robotics Evaluation Report

Mind - ROBOTICS Teacher

Please take this survey AFTER you have completed the Mind Comprehensive Robotics Module with your students. Answer the questions as thoroughly and as candidly as you can. Your responses will be used to help us continue to improve the Mind Virtual Labs for teachers and students. Thanks for your help!

General Teacher Survey - Demographics

Your Name

First name
Last name

Your School:

☐ Casey-Westfield High School  ☐ Okaw Area Center
☐ Central High School  ☐ Okawville Jr Sr High School
☐ Champaign Central HS  ☐ Our Lady of Grace School
☐ Eureka High School  ☐ Paxton Buckley Loda High School
☐ Farmington Central High School  ☐ Percy L. Julian
☐ Jacksonville High School  ☐ Prosser Career Academy
☐ Jersey Community High School  ☐ Rockford Jefferson High School
☐ Joliet West High School  ☐ Roosevelt Alternative High School
☐ Lawrenceville High School  ☐ Roxana High School
☐ Lemont High School  ☐ Salem Community High School
☐ Lyons Township High School  ☐ Steinmetz AC
☐ Marshall High School  ☐ Taft High School
☐ Minooka Community High School  ☐ Triad High School
☐ Momence High School  ☐ York Community High School
☐ Neoga Jr. Sr. High School  ☐ Other:
Your State:

- Alabama
- Arizona
- Arkansas
- California
- Colorado
- Connecticut
- Delaware
- District of Columbia
- Florida
- Georgia
- Idaho
- Illinois
- Indiana
- Iowa
- Kansas
- Kentucky
- Louisiana
- Maine
- Maryland
- Massachusetts
- Michigan
- Minnesota
- Mississippi
- Missouri
- Montana
- Nebraska
- Nevada
- New Hampshire
- New Jersey
- New Mexico
- New York
- North Carolina
- North Dakota
- Ohio
- Oklahoma
- Oregon
- Pennsylvania
- Rhode Island
- South Carolina
- South Dakota
- Tennessee
- Texas
- Utah
- Vermont
- Virginia
- Washington
- West Virginia
- Wisconsin
- Wyoming
- Hawaii
- I do not reside in the United States

What is the name of the school at which you teach?

How long have you been teaching?

- Not teaching yet
- Less than one year
- 1-3 years
- 4-6 years
- 7-8 years
- 10-12 years
- 13-15 years
- More than 15 years
- Retired
- Other ____________________
Describe the type of access that you have to a computer lab or classroom computers? (check all that apply)

- One computer in your classroom
- Several computers in your classroom
- Computer lab with one computer per student
- Computer lab with one computer for 2-3 students
- Wireless laptop lab
- Each student has their own laptop computer
- Other ________________

Which of the following technologies do you have available to use in your classroom? (check all that apply)

- Digital camera
- Scanner
- Digital microscope
- Software packages (associated with textbook companies)
- Software packages (other - list) ________________
- Online programs (list) ________________

How often do you use technology as a teaching tool?

- Never
- Rarely (yearly)
- Sometimes (monthly)
- Often (weekly)
- Always (almost daily)

Which online activities do you have your STUDENTS use at school? (check all that apply)

- Search Engine (Google, Yahoo)
- Social networking (Google+, Facebook)
- Chat/instant messaging (AIM, iChat)
- Blogging/micro-blogging (Blogspot, Blogger, Twitter)
- Online Audio Conferencing (Skype, GTalk, Gizmo)
- Social Bookmarking (Delicious, Pinterest, Digg)
- None
What types of games/game systems do have your STUDENTS use at school? (Check all that apply)

- Computer games that came free with the computer (Solitaire, Mindsweep)
- Free online video games for the computer
- Purchased video games for the computer
- Free games that came with cell phone/pda/smart phone
- Game apps that download to cell phone/pda/smart phone
- Handheld game systems (psp, DS, Gameboy)
- Games played on a video game system (PlayStation, Xbox)
- None

Which technologies do you use PERSONALLY? (check all that apply)

- Search Engine (Google, Yahoo)
- Social networking (Google+, Facebook)
- Chat/instant messaging (AIM, iChat)
- Blogging/micro-blogging (Blogspot, Blogger, Twitter)
- Online Audio Conferencing (Skype, GTalk, Gizmo)
- Social Bookmarking (Delicious, Pinterest, Digg)
- Wiki (Wikispaces, PBWiki)
- None

What types of games/game systems do you play PERSONALLY? (Check all that apply)

- Computer games that came free with the computer (Solitaire, Mindsweep)
- Free online video games for the computer
- Purchased video games for the computer
- Free games that came with cell phone/pda/smart phone
- Game apps that download to cell phone/pda/smart phone
- Handheld game systems (psp, Gameboy)
- Games played on a video game system (PlayStation, Xbox)
- None

Do you personally like using virtual game experiences to learn new educational topics?

- Yes
- No
- It depends
How do you prefer to learn new information?

- Read it in a book
- Look it up online
- Ask someone
- Do a hands-on activity.
- Do a virtual/online activity.
- Other ____________________

What challenges do you face at your school when considering implementing online modules--like those from The Mind Project? What could keep you from being able/willing to use online experiences with your students?

Questions About the Mind Comprehensive Robotics Module

Have you taught robotics before?

- Yes
- No

In how many classes have you taught robotics?

- 1-4
- 5-7
- 8+

Have you taught the Mind Robotics Module before this year?

- Yes
- No
When did you implement the Mind Comprehensive Robotics Module? (Select all that apply.)

- Spring 2009
- Summer 2009
- Fall 2009
- Spring 2010
- Summer 2010
- Fall 2010
- Spring 2011
- Summer 2011

Please answer the following questions with your most recent use of the Mind Comprehensive Robotics Module (i.e. Fall 2011/Spring 2012) in mind.

What was your level of knowledge about robots before you taught the Mind Comprehensive Robotics Module, on a scale of 1 to 10 (with 1 being no knowledge and 10 being expert)?

______ Level of knowledge

In what course(s) did you use the Robotics Module? (Check all that apply)

- Astronomy
- Biology
- Chemistry
- General science
- Health
- Math
- Physics
- Psychology
- Philosophy
- Other ____________________

What is the age group of the students that used the Robotics Module? (select all that apply)

- 8-11
- 12-14
- 15-16
- 17-18
- over 18
Is the Mind Comprehensive Robotics Module written at an appropriate level for your students?

☐ Yes, it was just right.
☐ No, it was too easy.
☐ No, it was too hard.

Please explain why it was not written at the appropriate level. If possible, provide specific examples.

How did you implement the Mind Robotics Module with your students? (Select all that apply)

☐ Individually (in a computer lab)
☐ Pairs (in a computer lab)
☐ Groups of 3 or more
☐ Project the lab on screen in front to entire class
☐ Individually (at home on their own time)
☐ Other ____________________

Did you use the Mind Robotics Module in whole or in part?

☐ Whole
☐ Part

What parts?

On average, how many hours did it take you to complete each of the following with your students? [Put N/A for activities that you did not do with your class]

Teacher preparation for modules
Introduction to Robotics section
Top-Down Virtual Lab
Bottom-up Hospital Task
Bottom-up Ethology Task
Supplemental activities [provided by teacher]
Wrap-up discussion or activities
How did you assign points for student participation in the Robotics Module? (Select all that apply)

- No points
- Completion grade
- Grade for work
- Online quiz score
- Additional project
- Extra credit
- Other ____________________

How did you use the Robotics Module with your students?

- Intro to new topic
- Activity during a unit
- Culminating event to a unit
- Stand alone activity
- Other ____________________

Did the module fit into your class’ curriculum?

- Yes
- No

Why did you choose to include the Robotics Module in your class and how did you fit it into your course work?

How did you fit it into your curriculum? If applicable, what objectives did the Robotics Module meet?

How would you rate the usefulness of the Robotics Module in the course in which you implemented it?

- Not Useful
- Somewhat Useful
- Useful
- Very Useful
Would you be interested in working with other lab activities similar to the Robotics Module in future courses?

- Very little chance
- Little chance
- A good chance
- A very good chance

How likely are you to recommend this Robotics Module to other teachers?

- Not at all likely
- Somewhat likely
- Likely
- Very Likely

Please explain why you are {SelectedChoices} to recommend this?

Are there any additional details you would like to add about how you implemented the Mind Comprehensive Robotics Module and your experience with the program?

Are you interested in physical robots to use in your classroom?

- Yes
- No

To apply for the robotics kit please tell us more about how you would use them. If you received the sample kit of 1 Iris1 robotic arm and 5 bugbots, how would you plan to use them? Please include: who will build them (presumably a smaller group of students)? And how will they be used after they are built?

Using the Virtual Robotics Labs in Your Classroom
How helpful was the Teacher Page in providing tips for you to implement the Robotics Modules in your classroom?

- Not at all helpful
- Somewhat helpful
- Helpful
- Extremely helpful

Do you have any suggestions for how we could improve the Teacher Page?

Which Virtual Robotics Lab did you use in your classroom? Check all that apply.

- Top-Down Virtual Robotics Lab (i.e. recycle a can task)
- Bottom-Up Virtual Robotics Lab (i.e. hospital robot & robot ethology)

Bottom-Up Virtual Lab

What do you think were the greatest strengths of the Bottom-Up virtual lab? What parts of the lab worked well?

What do you think were the most serious weaknesses of the Bottom-Up virtual lab?

Describe any navigation issues you had within the Bottom-Up Robotics Lab.

How effective were the readings in the Bottom-Up lab? How could they be improved?

What did your students enjoy most about the Bottom-Up Robotics Lab?

What did your students enjoy least about the Bottom-Up Robotics Lab?

What changes might YOU make to help the Bottom-Up Robotics Lab work for your students?
What implementation strategies or extension activities do you envision for the Bottom-Up Robotics Lab?

What changes could WE make to help the Bottom-Up Robotics Lab work better for students?

What suggestions do you have to improve the Bottom-Up Robotics Lab? Describe any information or resources that would improve the module.

Top-Down Virtual Lab

What do you think were the greatest strengths of the Top-Down virtual lab? What parts of the lab worked well?

What do you think were the most serious weaknesses in the Top-Down virtual lab?

Describe any navigation issues you had within the Top-Down Robotics Lab.

How effective were the readings in the Top-Down lab? How could they be improved?

What did your students enjoy most about the Top-Down Robotics Lab?

What did your students enjoy least about the Top-Down Robotics Lab?

What changes might YOU make to help the Top-Down Robotics Lab work for your students?

What implementation strategies or extension activities do you envision for the Top-Down Robotics Lab?

What changes could WE make to help the Top-Down Robotics Lab work better for students?
What suggestions do you have to improve the Top-Down Robotics Lab? Describe any information or resources that would improve the module.
APPENDIX B: AVERAGE PRE-POST SCORES BY QUESTION

<table>
<thead>
<tr>
<th>Question</th>
<th>Total N</th>
<th>Mean Pre-Test Score</th>
<th>Mean Post-Test Score</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you like learning about science, in general?</td>
<td>270</td>
<td>.79</td>
<td>.76</td>
<td>.318</td>
</tr>
<tr>
<td>Do you do well in your science class?</td>
<td>228</td>
<td>.89</td>
<td>.90</td>
<td>.434</td>
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<tr>
<td>Do you like learning about technology?</td>
<td>271</td>
<td>.89</td>
<td>.87</td>
<td>.201</td>
</tr>
<tr>
<td>Do you feel like you are good at using technology?</td>
<td>270</td>
<td>.91</td>
<td>.87</td>
<td>.034</td>
</tr>
<tr>
<td>Do you do well in your technology class?</td>
<td>180</td>
<td>.97</td>
<td>.97</td>
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<tr>
<td>Do you like playing online educational games?</td>
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<td>.50</td>
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<td>.170</td>
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<tr>
<td>What is your level of knowledge about robotics?</td>
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<td>3.59</td>
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<tr>
<td>How confident are you in your robotics skills?</td>
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<td>Do you have experience building robots?</td>
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<tr>
<td>Matching: Pre-programmed robots</td>
<td>273</td>
<td>.86</td>
<td>.89</td>
<td>.000</td>
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<td>Matching: Autonomous robots</td>
<td>272</td>
<td>.54</td>
<td>.74</td>
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<td>Matching: Teleoperated robots</td>
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<td>.80</td>
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<td>Matching: Augmented robots</td>
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<td>.54</td>
<td>.74</td>
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<td>This camera is an example of what part of a robot?</td>
<td>272</td>
<td>.86</td>
<td>.92</td>
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<tr>
<td>This gripper arm is an example of what part of a robot?</td>
<td>272</td>
<td>.57</td>
<td>.71</td>
<td>.000</td>
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<tr>
<td>Question</td>
<td>Total N</td>
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<td>Mean Post-Test Score</td>
<td>Significance</td>
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<td>----------</td>
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<td>Matching: Subsumption Architecture</td>
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<td>Matching: Has a Brain</td>
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<td>Matching: Uses Scripter</td>
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<td>Matching: Bottom-Up Robot Image</td>
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<td>.43</td>
<td>.79</td>
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<td>Matching Top-Down Robot Image</td>
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<td>Sum of General Robotics Questions</td>
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<td>9.40</td>
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<td>Which of the following best describes a top-down robot such as Iris.4?</td>
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<tr>
<td>Matching: An artificially intelligent agent that can communicate in human language...</td>
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<td>Matching: Allows all other software modules to communicate with each other</td>
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<td>.29</td>
<td>.43</td>
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<td>Matching: Can allow, block, alter or delete messages...</td>
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<td>.18</td>
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<td>Matching: Provides Iris.4 with a voice</td>
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<td>.81</td>
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<td>Matching: Allows Iris.4 to hear spoken language</td>
<td>243</td>
<td>.67</td>
<td>.79</td>
<td>.000</td>
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<td>Matching: Communicates scripts...</td>
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<td>.29</td>
<td>.54</td>
<td>.000</td>
</tr>
<tr>
<td>Matching: Allows Iris.4 to see...</td>
<td>241</td>
<td>.52</td>
<td>.74</td>
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<tr>
<td>Matching: Interprets digital Images</td>
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<td>Scripter program tells the robot when to move....</td>
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<td>Matching: Runs software, including the Mind Module</td>
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<td>Matching: Power supply</td>
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<td>.029</td>
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<td>Matching: Allow the robot to talk to people</td>
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<td>-------------------------------------------------------------------------</td>
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<td>Matching: Allows the robot to move from place to place</td>
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<td>Matching: Allows the robot to hear</td>
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<td>.75</td>
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<tr>
<td>Matching: Changes power from direct to alternating current</td>
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<td>.63</td>
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<td>Matching: Allows the robot to see</td>
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<td>Matching: Communicates between computer and wheels/arms</td>
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<td>Matching: Connects groups of computers together</td>
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<td>Matching: Serves as the body of the robot</td>
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