Experience of Robotic Teaching for Malaysian Gifted Enrichment Program at PERMATApintar

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Abstract: - This paper presents the experience of Malaysia gifted enrichment program called PERMATApintar Negara of conducting a robotic teaching program during 3 weeks holiday camp. During the camping period, the successfully selected primary school student among all over Malaysia for the program had explored the potential of using the LEGO NXT Mindstorms bricks to instill engineering skills, computer programming and creativity among them. The PERMATApintar Negara is a unique program conducted by Universiti Kebangsaan Malaysia (UKM) whereas highly potential students all around Malaysia is selected based on IQ test called UKM1 and UKM2. By using the LEGO NXT Mindstorms that has been largely used as an affordable, motivational and effective teaching material for robotic and programming, the camp can provide hands-on experience which gave the selected students the opportunity for creativity and sense of achievement. It has been proved that during our camp, the students can upgrade their sense of creativity by developing various types of robot with the versatility of LEGO NXT Mindstorms.

Key-Words: - Robotic, LEGO, Gifted, Enrichment Program, PERMATApintar

1 Introduction

In modern technology advances especially in the crucial fields such as computer and automation, there is a continuous demand for highly motivated and skilled engineers. In order to meet this demand, technology curriculum is needed at the school level to give students insight into engineering fields and attract students to mathematics, science and technology studies instead of the traditional way of classroom which can be dull and less appealing to students(Seefelt, 1999). Educationist proposed that the technology curriculum at the school level should discard the confined professional bias and provide an insight into engineering science which is opposed to the traditional vocational education approach (Waks, 1995). Therefore, new approaches to design an appropriate modern strategy for implementing high quality of technology program at school level are needed. In the effort of stimulating especially young generations at early childhood ages from primary school students to get involved with engineering, science and technology, robotics in which today have being a multifaceted representation of modern science and technology seem to be a topic that will attracts the interest of young children.

Traditionally, robots have been programmed by high complexity or even a low level computer languages, which would tend to mitigate against their use within education. An interesting approach to address this has been taken by an international group of researchers who work in evolutionary robotic design. They have successfully demonstrated the use of evolutionary robotic approaches that can enable children to design for themselves a range of simple robotic behavior such as collision avoidance, line or wall following(Lund et. al., 1998). Seymour Papert, supports an approach of learning in the classroom which he calls ‘constructionism’, opposed to the traditional style of ‘instructionism’ (Papert, 1993). He means that children will do best by finding or ‘fishing’ for knowledge by themselves. Improvisational, self-directed, ‘playful’ activities should simulate the more ‘natural’ way in which children seem to learn outside the classroom. Instead of a one-way and top-down transmission of knowledge from teacher to child, an appropriate learning environments could be used as ‘personal media’ to develop a different relationship that is knowledge in a new style of learning, which can account for personal variation in learning styles.
2 Robotic class at PERMATApintar

When young children have a basic knowledge of robotics among them, it can encourage them to learn more about various types of robots such as industrial robot, humanoid robot, rescue robot and others. We believe that the basic knowledge of robotics can lead to the development of their critical thinking skills which is the most important to be a future scientist, engineers or researchers and LEGO NXT Mindstorms fits into this planning perfectly.

The PERMATApintar Negara holiday camp program which is fully sponsored by the Government of Malaysia is committed to use robotics in order to encourage young gifted children to learn science and technology. Through our gifted enrichment program, we tend to create a more technologically literate youngsters in Malaysia. The PERMATApintar Negara holiday camp program is conducted for 3 weeks in November and December every year with the participations are expected to be increased each year. It is a unique program conducted by Universiti Kebangsaan Malaysia (UKM) whereas highly potential students all around Malaysia is selected based on IQ test called UKM1 and UKM2. The first holiday camp was successfully conducted in 2009 with 420 students from the age of 9 until 15 years old. Out of this numbers, 48 students with ages of 12 years old were selected to attend the robotic classes.

The Introduction to Robotics (RO) course was divided into 3 classes where in each class there was an instructor and a teaching assistant(TA). The instructors and TAs was selected based on their expertise and experiences both in teaching pedagogy and robotic contents as well. In 2009 session, the first class of robotic (RO1) was conducted by a master student in mechatronic with a teaching experience in school and matriculation college for more than 10 years. The second class of robotics (RO2) instructor was a senior mathematic teacher at a well known boarding school in Malaysia. The third class of robotics (RO3) instructor was a master student of information technology(IT).

The objectives of The Center for PERMATApintar Negara introducing the Introduction to Robotics course is to develop a mathematical competency and technological literate children students. We also want to influence the children to be more interested in robotics and at the same time having fun with experimenting the robot technologies. In our PERMATApintar program, we allow children to design, build and program their own robots and they will get involved in many technical activities that also overlap with several other disciplines like mathematics, engineering, electronics, IT, science and technology in general. During their 3 weeks camping period, they also have to learn how to work in teams and faced many difficult technical decisions in order to enhance their management skills.

We at PERMATApintar Negara use robotic as the tools for engaging teachers and young children in mathematic, science, technology and engineering by providing opportunities for the active design. In general, robotic is an engineering art combining electrical, electronic, computer science and mechanical engineering technologies. By meaningful projects to explore and play with new concepts, it can stimulate and motivate the ways of thinking to solve what they think is a real world problems. In the industrial area, robotic arms are widely used to increase productivity, and hence production capacity since it can replace the human labor because robots can perform a tasks more accuracy, consistent and faster than human being. Besides that, robots can be substituted for humans in hazardous or uncomfortable work environments.

However, due to the complexity of robotics studies, it is hard to attract and pass the knowledge to the students. This can be overcome by developing interest among student at early ages by introducing the simplest robotic knowledge to them.

![Input and output ports](image)

**Fig. 1 Input and output ports**

In our robotic classes, we use robotics construction sets of the LEGO NXT series(LEGO, 2010). This sets represent an ideal tool for our purpose not only serving as a physical model for programming,
but also being easy to handle and still allowing a lot of freedom for students' creativity. The LEGO NXT Mindstorms is set consists of structural and mechanical building parts such as gears, axles, and beams, a programmable NXT intelligent brick, several motors, and sensors. The NXT intelligent brick (I-Brick) is a programmable device, build-in speaker, push buttons and plugs to connect to input and output devices. In order to download a program created in a PC, it can be connected to a PC via a USB, or alternatively we can use Bluetooth capability which also allows direct communication between I-Brick. Among the sensor that are available in the packet include touch sensor, ultrasonic sensor for measuring distance to an object, sound sensors, light sensors and rotation sensors.

3 NXT Programming

Figure 1 shows the structure of I-Brick. There are three output ports to connect with servo motors, and four input ports to connect various types of sensors. The basic NXT kit comes with touch sensor, sound sensor, light sensor, and ultrasonic sensor. Figure 2 shows a line follower robot built using the NXT Mindstorms kit. The robot vehicle uses a light sensor to follow a color boundary on a smooth surface. At the same time, that robot also will turn towards the opposite direction on the track when detect obstacle which is situated in front of it in certain distance.

Figure 3). Beside the NXT-G, other programming languages that used text based language such as NXC (Not eXactly C), ROBOT C, Java, MATLAB, leJOS NXJ and others are also available (Kim 2007). However, for a primary school students, these programming language are not very suitable since it needs a basic text based programming experience.

In our class, we controlled the NXT by a graphical programming language named NXT-G (see Figure 3). Beside the NXT-G, other programming languages that used text based language such as NXC (Not eXactly C), ROBOT C, Java, MATLAB, leJOS NXJ and others are also available (Kim 2007). However, for a primary school students, these programming language are not very suitable since it needs a basic text based programming experience.

In the experiment, a test pad created from a white paper (1m x 1m) and black tape with distance of the track of 240cm is used. The line follower robot had been set up with two programming languages i.e., NXT-G and NXC. The parameters which was set for both two programming languages are speed (30% of maximum speed), distance of obstacle detectable (15cm), and contrast of light (50). This experiment was repeated three times for both languages used respectively.

The average value of both experiment is shown in Table 1. It seems that the robot which was programmed by NXC can move at higher speed if compare to robot programmed by NXT-G. It is assumed that because the NXC is a text based programming language and I-Brick does not expend resources on processing the graphics, which generally requires more system resources than text does . For the same reason, text-based applications use memory more efficiently.
4 Conclusions

In this paper, we presented the experience of PERMATApintar Negara gifted enrichment program conducting a robotic class. The idea of learning by playing and hands-on experience which stands behind the LEGO kits has been adopted in our PERMATApintar Negara program. Through our extensive 3 weeks program, the children have proved that they were able to perform an extensive programming skills of NXT-G, building a various types of complicated robots, self confidence in demonstrating and presenting their work as well as interactive social skills between them.

Finally, we believed that the use of LEGO NXT Mindstorms as a medium of teaching robotics enabled us to facilitate an active learning environment, interpersonal communication skills and programming skills among the students attended our camp.

5 Acknowledgement

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Table 1 Time of robot traveled

<table>
<thead>
<tr>
<th>Test</th>
<th>Time taken (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NXC program</td>
</tr>
<tr>
<td>1</td>
<td>46.5</td>
</tr>
<tr>
<td>2</td>
<td>47.1</td>
</tr>
<tr>
<td>3</td>
<td>46.9</td>
</tr>
<tr>
<td>Average</td>
<td>46.8</td>
</tr>
</tbody>
</table>

References:

2- LEGO. LEGO Mindstorm official site: http://mindstorm.lego.com/ (last visited 30 May 2010)