Competency Improvement Needs of Metalwork Teachers in the Use of Computer Numerically Controlled Machine Tools in Technical Colleges in Oyo State Nigeria

Emmanuel O. Ede¹ and Ariyo Samson O².
¹&² Department of Vocational Teacher Education, University of Nigeria, Nsukka
emmanuel.ede@unn.edu.ng, ariyotimi@yahoo.com

Abstract
The purpose of the study is to determine the Competency Improvement Needs of metalwork teachers in the use of computer numerically controlled machine tools in technical colleges in Oyo State, Nigeria. Two specific purposes and research questions guided this study. A survey research design was adopted for the study. The study was carried out in Oyo State, which is located in the southwestern part of Nigeria. The population for the study comprised of all the 35 metalwork teachers in the technical colleges in Oyo State. A 44 competency item questionnaire was developed and used to collect data. The questionnaire had two types of scale responses of required and performance. The questionnaire was validated by three experts in technical education. Cronbach’s Alpha was used to determine the reliability coefficient of the instrument, which yielded a co-efficient of 0.86. Data obtained were analyzed using mean and Improvement Needed Index (INI) to answer the research questions. It was found out by the study that the teachers needed improvement in 18 competencies identified by the study. It was therefore recommended that the findings of this study be utilized to organize in-service training programmes for the teachers to enable them use CNC machines effectively.

Keywords: Competency Improvement Needs; Computer Numerically Controlled Machine Tools; Teacher Training; Technical Colleges; Technical and Vocational Education

Introduction
Technical colleges are institutions where students are trained to acquire relevant knowledge and skills in different occupations for employment in the world of work. Okorie (2001) explained that technical colleges in Nigeria are established to prepare individuals to acquire practical skills and basic scientific knowledge within the confinement of a technical institution or industrial technical education unit. According to the National Board for Technical Education (NBTE, 2004), Technical colleges in Nigeria are established to produce craftsmen at the craft (secondary) level and technicians at the advanced craft (post-secondary) level. Metalwork trade is one of the subjects that are taught in technical colleges in Nigeria. Metalwork trade comprises a blend of both theory and practical that leads to the production of goods and services by the use of tools, equipment and metalwork materials (NBTE, 2001). At the technical colleges, metalwork comprises of other sub-modular trade components such as machine shop practice, welding and fabrication, forging, heat treatment and foundry.
practices. Nwoke and Ogwo (2002) explained that metalwork involves activities in occupations that entail designing, processing and fabrication of metal products; it includes activities in foundry, forging, machine shop and welding. Considering the various importance of metalwork to everyday life and also the overall objective of vocational and technical education (in which metalwork is one) which offers training in skill for self-reliance, self-sufficiency and employment into the world of work, metalwork becomes an important subject to be taught to student.

The need for improvement in technical education development is an area which is in focus of both the professional and lay public in Nigeria. There are different areas of technical education that needs improvement, but the importance of improving teacher’s competency cannot be overemphasized. Competency according to Grove (1993) is a quality or state of being functionally adequate or having knowledge, skill or strength. Olaitan (2003) said to be competent implies that an individual has acquired the knowledge, skills, attitudes and judgments which he requires in order to perform successfully at a specified proficiency level in a given work.

The future of educational and technological development of Nigeria depends on the quality of technical teachers, because they teach the students who are expected to be productive workers and leaders of tomorrow. These technical education teachers need to be effective and efficient in order to teach students well. Technical education teachers need competency improvement in some aspects of technical education curriculum because of the dynamic nature of technical education. This requires that teachers be exposed to new methodologies and curriculum innovation in their areas of specialization during the course of their training programme. The success of any educational system no matter how well it is planned depends to a large extent on the quality of teachers. The greatest obstacle encountered in Nigerian schools is the use of teachers who are not professionally skilled. Most metalwork teachers in technical colleges have insufficient and inadequate knowledge in the use of new technologies which make them incapable to perform their functions of imparting knowledge to the learners efficiently and effectively.

Kennedy (2011) said a teacher who is not currently in tune with modern trend is dangerous to the system. The field of technical education of which metalwork is a part of is dynamic and ever changing, this is because new and better machines are being produced on a regular basis for better, easier, faster and more accurate production of work pieces. This frequent development of new metalwork machines renders the previous machines obsolete and outdated. Some existing metalwork teachers were trained on these obsolete equipments or have worked with such equipments for a long time that their skills need to be updated. These types of teachers cannot make use of modern equipments like the Computer Numerically Controlled machines to effectively teach students of metalwork in technical colleges.

The Computer Numerically Controlled (CNC) machine is a technology in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric program data. CNC machine can control the motions of the work piece or tool. The introduction of Computer Numerically Controlled machines radically changed the manufacturing industry; CNC machines have enabled industries to consistently produce parts automatically with amazing speed, accuracy, efficiency and repeatability. There are two types of CNC machines; they are the Computer Numerically Controlled Lathe Machine and Computer Numerically Controlled Milling Machine. To effectively use these
machines the teacher must possess a certain level of competency in the relevant technical skills. The use of Computer Numerically Controlled machine tools has spread rapidly during the last decade. Abdullah and Hassan (2012) stated that 27% of the manufacturing industries worldwide reportedly use CNC machine tools for their production. This has made the Oyo State Government to commission the National Agency for Science and Engineering Infrastructure (NASENI) to carry out infrastructural inspection of the technical colleges in the state for the expansion of the advanced manufacturing technology programme, including the use of CNC machine tools. This is with the aim of making technical colleges in Oyo state trail blazers in the area of advanced manufacturing technology and use of CNC machine tools. Metalwork teachers from both urban and rural areas of Oyo State were used in this study.

Statement of the Problem
Adebayo (2007) stated that changes in technology have caused graduates of metalwork technology in Nigeria not to fit into the present world of work without being re-trained. Changes in technology have caused the relationship between education and work in modern societies to become extremely complex. The use of computer numerically controlled machine tools in the industry is not in line with the content of teaching in technical institutions and this has become a problem for the industries because students lack the required skills needed in using these machine tools. This has made employers of labour to be reluctant in engaging the services of metalwork graduates because such graduates are unusable in the modern industries without further training. This according to Dawodu (2002) is as a result of the fact that most metalwork teachers do not possess the requisite skills needed in using new technologies, hence they have no skills to impart to the learners. To help solve this problem, it is important to know how competent the metalwork teachers are in the use of computer numerically controlled machine tools.

Specific Purposes
The general purpose of this research is to determine the areas where metalwork teachers need improvement in the use of computer numerically controlled machine tools. The research goals are to study and find the improvement needs of metalwork teachers in use of computer numerically controlled machine tools in technical colleges in Oyo state, Nigeria. Specifically the research will seek to:

i. Determine the improvement needs of metalwork teachers in using CNC lathe machine
ii. Identify the skills that require improvement by metalwork teachers in the use of CNC milling machine

Research Questions
The following research questions were formulated to guide this study:

(1) What are the competencies in using computer numerically controlled lathe machine which teachers of metalwork need improvement.
(2) What are the competencies in using computer numerically controlled milling machine which teachers of metalwork need improvement.

Methodology
The survey research design was adopted for the study. Nworgu (2006) stated that a survey research design is one in which a group of people or items are studied by collecting and analyzing data from a few people or items considered to be the representative of the entire group. The study was carried out in Oyo State, in the South western part of Nigeria. The
population for the study was made up of all the 35 metalwork teachers from the four technical colleges in Oyo State. Since there are no standardized instruments in this field, and given the nature of the research a 44 Competency Item Questionnaire was developed and used for data collection. The questionnaire had two categories – Level of requirement and Level of performance. The required category had a 4 point response scale of Very Highly Required, Highly Required, Moderately Required and Not Required with corresponding values of 4, 3, 2 and 1 respectively while Performance category had a response scale of High Performance, Average Performance, Low Performance and No Performance with corresponding scores of 4, 3, 2 and 1 respectively.

The instrument was face validated by three experts. One from the Advanced Manufacturing Unit, Scientific Equipment Development Institute, Akuke, Enugu and two experts from the Department of Vocational Teacher Education, University of Nigeria Nsukka. To ascertain the internal consistency of the instrument Cronbach Alpha was used. The reliability coefficient of the instrument was calculated to be 0.86. Thirty five (35) copies of the questionnaire were administered on the respondents and retrieved with a 100% return rate. The data collected was analysed using weighted mean and Improvement Needed Index (INI) adopted from Olaitan, Amusa and Nwobu, (2010) to answer the research questions. The improvement needed by the teachers was determined as follows:

(a) The weighted mean ($X_R$) of the required scale was determined for each item
(b) The weighted mean ($X_P$) of the performance scale was determined for each item
(c) The performance gap (PG) was determined by finding the difference between the values of $X_R$ and $X_P$, that is $X_R - X_P = PG$

Where PG is negative (-), it means improvement is not required because the level at which the teachers could perform that item is greater than the level at which it was needed. Where PG is positive (+), it means improvement is needed because the level at which the teachers could perform that item is lower than the level at which it is needed. Where PG is zero (0), it means improvement is not needed because the level at which the teachers could perform that item is equal to the level at which it is needed.

Analysis and Interpretation of Research Results
In this part of the paper, we aim to find out which skills metalwork teachers require improvement in effectively using CNC machine tools. We analyzed teachers responses on which skills require improvement in the use of CNC lathe machine and CNC milling machine. The results are presented below.

Table 1. Performance gap analysis of the mean ratings of the responses of metalwork teachers on competencies in using computer numerically controlled lathe machine

<table>
<thead>
<tr>
<th>S/N</th>
<th>Item Statement</th>
<th>$X_R$</th>
<th>$X_P$</th>
<th>PG</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set lathe machine cutting tool according to specification for the job to be performed</td>
<td>3.51</td>
<td>3.62</td>
<td>-0.11</td>
<td>INN</td>
</tr>
<tr>
<td>2</td>
<td>Generate plane surface on the lathe using a straight edge cutting tool</td>
<td>3.62</td>
<td>3.77</td>
<td>-0.15</td>
<td>INN</td>
</tr>
<tr>
<td>3</td>
<td>Select the tail stock for altering the path of tool or taper turning on the lathe.</td>
<td>3.54</td>
<td>3.82</td>
<td>-0.28</td>
<td>INN</td>
</tr>
<tr>
<td>4</td>
<td>Change the path of tool on the lathe for taper</td>
<td>3.55</td>
<td>3.74</td>
<td>-0.19</td>
<td>INN</td>
</tr>
</tbody>
</table>
5. Generate hole on metals with twist drill or reamer held in the lathe tailstock.

6. Enlarge hole drilled on the metal using the boring tools held in the lathe tailstock.

7. Part-off a specified length from a work piece on the lathe.

8. Insert thread-cutting tool into the tool holders for different thread cut operation on the lathe.


10. Select suitable cutting speed for a particular size of material to be machined on the lathe.

11. Drill various materials on lathe machines.

12. Enlarge holes with accuracy on lathe machines.

13. Cut and enlarge a hole accurately on lathe machines.

14. AUTOCAD production of the specimen to be machined.

15. Knowing how to pick position points from the AUTOCAD drawing of the specimen to be machined.

16. General knowledge of computer programming

17. Interpret technical and engineering drawings

18. Install software from a CD.

19. Use keyboard appropriately

20. Recognize the computer numerical control codes.

21. Know the meaning of each code command

22. Use the computer numerical control codes to write programmes.

$X_R = \text{Mean of competencies required; } X_P = \text{Mean of teachers performance; } PG = \text{Performance gap; } IN = \text{Improvement needed; } INN = \text{Improvement not needed}$

Data in Table 1 revealed that 11 competency items had negative values ranging from -0.03 to -0.28 while 3 competency items had values of 0.00, this showed that teachers do not need improvement in these items as they are already performing at the required level. Competency items 14, 15, 16, 18, 19, 20, 21, and 22 had their performance gap values range from 1.79 to 2.56 and were positive. This showed that the teachers needed improvement in these competency items.

Table 2. Performance gap analysis of the mean ratings of the responses of metalwork teachers on competencies in using computer numerically controlled milling machine
<table>
<thead>
<tr>
<th>S/N</th>
<th>Item Statement</th>
<th>$X_R$</th>
<th>$X_P$</th>
<th>$PG_{X_R-X_P}$</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.</td>
<td>Cut horizontal surface on the milling machine</td>
<td>3.54</td>
<td>3.62</td>
<td>-0.08</td>
<td>INN</td>
</tr>
<tr>
<td>24.</td>
<td>Cut angular surface on milling machine</td>
<td>3.51</td>
<td>3.60</td>
<td>-0.09</td>
<td>INN</td>
</tr>
<tr>
<td>25.</td>
<td>Cut key way on the milling machine</td>
<td>3.34</td>
<td>3.37</td>
<td>-0.03</td>
<td>INN</td>
</tr>
<tr>
<td>26.</td>
<td>Cut groove on the milling machine</td>
<td>3.42</td>
<td>3.54</td>
<td>-0.12</td>
<td>INN</td>
</tr>
<tr>
<td>27.</td>
<td>Cut dovetail on the milling machine</td>
<td>3.50</td>
<td>3.45</td>
<td>0.05</td>
<td>IN</td>
</tr>
<tr>
<td>28.</td>
<td>Cut t-slot on the milling machine</td>
<td>3.40</td>
<td>3.45</td>
<td>-0.05</td>
<td>INN</td>
</tr>
<tr>
<td>29.</td>
<td>Set the knee elevation on the milling machine</td>
<td>3.66</td>
<td>3.69</td>
<td>-0.03</td>
<td>INN</td>
</tr>
<tr>
<td>30.</td>
<td>Set the table elevation on the milling machine</td>
<td>3.63</td>
<td>3.71</td>
<td>-0.08</td>
<td>INN</td>
</tr>
<tr>
<td>31.</td>
<td>Select suitable cutting speed to suit the material being milled</td>
<td>3.62</td>
<td>3.71</td>
<td>-0.09</td>
<td>INN</td>
</tr>
<tr>
<td>32.</td>
<td>Set the feed rate to suit the material being milled</td>
<td>3.57</td>
<td>3.65</td>
<td>-0.08</td>
<td>INN</td>
</tr>
<tr>
<td>33.</td>
<td>Select milling cutter suitable for the surface to be generated</td>
<td>3.65</td>
<td>3.72</td>
<td>-0.07</td>
<td>INN</td>
</tr>
<tr>
<td>34.</td>
<td>Mount milling cutter firmly on the arbor, or other holder available on the machine</td>
<td>3.46</td>
<td>3.65</td>
<td>-0.19</td>
<td>INN</td>
</tr>
<tr>
<td>35.</td>
<td>Determine the feed in relation to the direction of cutter rotation</td>
<td>3.60</td>
<td>3.54</td>
<td>0.06</td>
<td>IN</td>
</tr>
<tr>
<td>36.</td>
<td>AUTOCAD production of the specimen to be machined</td>
<td>3.54</td>
<td>1.54</td>
<td>2.00</td>
<td>IN</td>
</tr>
<tr>
<td>37.</td>
<td>Knowing how to pick position points from the AUTOCAD drawing of the specimen to be machined</td>
<td>3.60</td>
<td>1.66</td>
<td>1.94</td>
<td>IN</td>
</tr>
<tr>
<td>38.</td>
<td>General knowledge of computer programming</td>
<td>3.54</td>
<td>1.34</td>
<td>2.20</td>
<td>IN</td>
</tr>
<tr>
<td>39.</td>
<td>Interpret technical and engineering drawings</td>
<td>3.60</td>
<td>3.68</td>
<td>-0.08</td>
<td>INN</td>
</tr>
<tr>
<td>40.</td>
<td>Install software from a CD</td>
<td>3.63</td>
<td>1.72</td>
<td>1.91</td>
<td>IN</td>
</tr>
<tr>
<td>41.</td>
<td>Use keyboard appropriately</td>
<td>3.63</td>
<td>1.66</td>
<td>1.97</td>
<td>IN</td>
</tr>
<tr>
<td>42.</td>
<td>Recognize the computer numerical control</td>
<td>3.64</td>
<td>1.29</td>
<td>2.35</td>
<td>IN</td>
</tr>
</tbody>
</table>
codes

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</thead>
<tbody>
<tr>
<td>43</td>
<td>Know the meaning of each code command</td>
<td>3.71</td>
<td>1.26</td>
<td>2.45</td>
</tr>
<tr>
<td>44</td>
<td>Use the computer numerical control codes to write programmes</td>
<td>3.71</td>
<td>1.17</td>
<td>2.54</td>
</tr>
</tbody>
</table>

\[X_R = \text{Mean of competencies required}; \ X_P = \text{Mean of teachers performance}; \ PG = \text{Performance gap}; \ IN = \text{Improvement needed}; \ INN = \text{Improvement not needed}\]

Data in Table 2 revealed that 12 competency items had negative values ranging from -0.03 to -0.19 this showed that teachers do not need improvement in these items as they are already performing at the required level needed. While Competency items 27, 35, 36, 37, 38, 40, 41, 42, 43 and 44 had their performance gap values range from 0.05 to 2.54 and were positive. This showed that the teachers needed improvement in these competency items.

Discussion

The findings of the study indicated that out of 22 items on competency improvement needs of metalwork teachers with respect to using computer numerically controlled lathe machine 8 items were adjudged to require improvement by metalwork teachers in technical colleges in Oyo state, they are AUTOCAD production of specimen to be machined, knowing how to pick position points from AUTOCAD drawings, general knowledge of computer programming, recognizing CNC codes, knowing the meaning of each CNC code, using the CNC codes to write programmes, installing software from a CD and using computer keyboard appropriately. These findings are in agreement with Ogwo and Oranu (2006) when they stated that teachers must be continuous learners through improvement or training programmes.

Further, the results of the study showed that out of the 22 items on competency improvement needs of metalwork teachers in technical colleges with respect to using computer numerically controlled milling machine, it was found out that teachers required improvement on 10 items these include cutting dovetail on the milling machine, determining the feed in relation to the direction of cutter rotation, AUTOCAD production of specimen to be machined, knowing how to pick position points from AUTOCAD drawings, general knowledge of computer programming, recognizing CNC codes, knowing the meaning of each CNC code, using the CNC codes to write programmes, installing software from a CD and using computer keyboard appropriately. This finding is totally not unexpected due to the dynamic nature of technical education because most of these metalwork teachers were trained when this new technology has not yet appeared. This is in line with Mohd Fauzi (2000) who stated that technical education teachers nowadays acquire little of modern skills such as skills required to maintain or operate computer numerically controlled machine tools.

Conclusion

Based on the findings of this study, it can be concluded that metalwork teachers are deficient in some technical skills in the use of computer numerical control lathe and milling machines. We can also clearly conclude that, the computer and ICT skills possessed by metalwork teachers in Oyo State are not adequate enough to allow them use CNC machine tools.
effectively. These competency problems appear due to the lack of knowledge on how to apply ICT and the knowledge about computer numerical control codes to support teaching and also the lack of technical support from the government. But excuses are no longer accepted, and it is time for all the teachers to gear up and learn the required skills and knowledge on ICT and CNC machines tools. Having a positive perspective on something can help teachers to improve their self periodically. This study also concludes that policy makers who are responsible in formulating the policies related with teaching and learning should make the appropriate and responsive policies to the needs of teachers. Also, capacity building and competency improvement programmes could be organized for these teachers using workshop and seminars in order to improve their technical skills in the use of these machine tools.

**Recommendations**

Based on the findings of this study, it is hereby recommended that:

i. The Federal and State ministries of education should, through the science and technical schools management board, set in motion a process for providing in-service training to metalwork teachers who lack required skills in using computer numerically controlled machine tools.

ii. Government and employers of metalwork graduates should donate modern machine tools to technical colleges in Oyo state.

iii. Technical skills that were identified by metalwork teachers that require improvement in the use of computer numerically controlled machine tools should be integrated into the curriculum of metalwork teacher preparation institutions such as colleges of education and universities.

iv. As Nigeria is a developing country, metalwork teachers should be sent for training programmes to technologically developed countries that have mastered the use of computer numerically controlled machine tools efficiently.

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