INTELLIGENT MODEL TO PREDICT THE SUBJECT OF STUDY FOR INCLUSION STUDENT BASED ON HISTORIES BACKGROUND

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Abstract: Inclusive education for young disabled people is a trends, issues and big challenges. Young disabled people have fewer chances to get a properly job as they are more likely to drop out after the first year and to have erratic and longer pathways within the University education. Hence, the aim of the project is to deliver an intelligent model for the university management to easy guide the candidates of disable students in selecting the best subject of their study. The project will be begun with literature reviews and then will be concentrated on the early survey (questionnaire) of the student histories. The information will be analyzed and classified to serve as references in determining of the academic factors. The next step is developing the database of background histories as input system and academic performance as output of the system. The back propagation Neural network (BPNN) will be trained to build the complex relationship between input and output system. Finally, the system will deliver a NN tool to select the best of subject of study based on grade performance and histories background.

Keywords: disable student, education performance, neural network, subject of study

I. INTRODUCTION

Social ministry of Republic of Indonesia has signed the United Nation Convention on the rights of persons with disabilities since March 30, 2007. And then President of Republic of Indonesia has agreement to put the Committee on the Rights of Persons with Disabilities (CRPD) as one part of law in No. R-31/pres/06/2011 on June 23, 2011 [1]. It shows how strong the commitment of Indonesian government to education for all, and more recently a growing commitment to inclusive education, has increased opportunities in mainstream education in all countries. The commitment to education for all has led countries to allocate additional technical, financial and human resources aimed at empowering schools and higher education institutions to be accessible for them. All these resources are intended for institutions to meet the requirements of disabled students for access to the same opportunities as their non-disabled peers.

The quality of education for disable student is to be basic to get a properly job in any areas including industry, government, service, etc. It is depending to the institution/the University to manage the process of education. There have been many studies that sought to examine this issue and their findings point out to hard work, previous schooling, parents’ education, family income and self motivation as factors that have a significant effect on the student grade point average (GPA). The limiting the students that fail in the final examinations is considered essential and therefore the ability to predict weak students could be useful in a great number of different ways [2]. The quality of higher education institutions implies providing the services, which most likely meet the needs of students, academic staff, and other participants in the education system [3]. The success of disabilities education process involves many factors e.g. class facility, input of students, teacher, etc. In sort, it is very important for management of disable institution to understand which subject of study will give a serious impact in successfully student from students’ perspective and what is the technical responds to gain high quality education.

A neural network (NN), which imitates the human brain in problem solving, is a more general approach that can handle this type of problem. Hence, our attempt is to build an adaptive system such as the Artificial Neural Network to predict the performance of a candidate based on their background histories. According to NN model, the user can easily select any kinds of subject of study to get the best performance.

Based on the aim of the research is to deliver an intelligent model for the University
management, the objectives of the research can be written as:
1. To gather student's data and their marks and technical, analytical, communicational and problem solving abilities.
2. To summarize some suitable factors that affects an inclusion student’s performance.
3. To transform these factors into database
4. To train a BPNN module based on the database information.
5. To help the institute/department of the University to accurately predict the performance of the disable students for their growth.

II. MATERIAL AND METHOD
2.1. Disable student
Disable students are students with some physical or mental impairment that substantially limits one or more major life activities. Usually disabled students have low academic achievement. Many students with disabilities have difficulty remembering information presented visually or auditorially. The most of these students forget spelling words, math facts, vocabulary words, and directions. Disabled students need some attention problems. They are feel difficult to screen out extraneous stimuli and are attracted by irrelevant stimuli. Difficulties with social skills can be as debilitating as academic problems to students with disabilities. Frustrated by their learning difficulties, many students with disabilities doing disruptively and acquire bad feelings of self-worth. Rather than learning and developing attitudes about tasks they can do, youngsters with disabilities often learn what they can’t do. This lack of positive self-regard often results in poor self-concept and self-esteem.

There are many classification of disable student, it is depend on their disabilities or their limitation, such us understanding, working, walking, seeing, and hearing. Following explanation is some example of type of disabilities and the limitation.

- Attention deficit disorder (ADD)
  Attention deficit disorder (ADD) is a disability class of neurobiological disorder. The ADD student has limitations in completing tasks, controlling impulsivity, or sustaining attention.

- Blindness and Low vision
  Blindness can be caused by congenital (occurring before or at birth), natural disaster (tsunami, earthquake, etc.) or a result of trauma or a medical disorder.

- Deaf and Hard of hearing
  Deaf and hard of hearing is a disability problem that following with difficulty to speak to another person.

- Chronic Health Impairments
  The chronic health impairments are invisible and visible disabilities. Chronic Health impairments include AIDS, allergies, back disorders, burns, cancer, Crohn's disease, diabetes, fibromyalgia, heart disease, hemophilia, lupus, multiple sclerosis, muscular dystrophy, renal-kidney disease, respiratory disorders, seizure disorders, sickle cell anemia, Tourette's syndrome. Side effects of medication may include fatigue, memory loss, shortened attention span, loss of concentration, or drowsiness.

- Slow learner
  Students have limitations in critical thinking, inferential reading, analysis or synthesis, and abstract reasoning.

- Head Injury
  Traumatic brain injuries result from either external events such as a blow to the head, or internal events, such as a tumor or stroke. Limitations vary depending upon the type, location, and severity of the injury. The student is usually limited in cognitive functioning in the area of memory, concentration, speed of response, spatial reasoning, conceptualization, problem-solving, motor functioning or communication through reading, writing, speaking, or listening.

- Learning disabilities
  Title V of the California Education Code defines learning disabilities as a persistent condition of presumed neurological dysfunction which may exist with other disabling conditions. This dysfunction continues despite instruction in standard classroom situations. Students with learning disabilities exhibit average to above average intelligence ability, severe
processing deficits, severe aptitude-achievement discrepancies, and measured achievement in an instructional or employment setting.

- **Mobility Impairments**
  
  There are a wide range of neuromuscular and orthopedic impairments that are congenital, the result of illness, or accident related. Mobility impairments range from slight difficulties with movement to paralysis. Such impairments may be caused by disorders such as arthritis or multiple sclerosis, or they can have congenital causes such as cerebral palsy or muscular dystrophy. They can also be the result of illness, accidents, strokes, or injury to the spinal cord. Some students have impairments in arm or hand movement that are the result of repetitive strain injury. These strain injuries can fluctuate in severity and are susceptible to aggravation from overuse.

- **Psychological disabilities**
  
  Psychological disabilities cover a wide range of conditions varying in symptoms and severity. Most students with these psychological disabilities are limited with communication because they react to the increased stress of college by withdrawing. Psychological disabilities limit times of class choice because the student's functioning fluctuates throughout the day. Student's attendance may be limited because of relapses or hospitalizations.

**Subject of Study**

Selecting subject of study sometimes is difficult for not only students or parents but also the University staffs as it can impact on the student success in the future. It is more difficult to guide disable student in selecting the subject of their study. Academic histories, family background, personal experience and guiding from the University destination are needed to find the best subject.

The student candidates should have information course of study, applying, and planning out their studies. The student advice centre usually offers special explanation in selecting the best course of study each candidate student. It is helpful to first decide what field of study interests for disable student and then later a concrete subject. The accuracy of selecting the subject of study importantly impact on student performance as especially for disable student, e.g. their motivation, their ability, their attitude, etc. Limitation to communicate with the candidate of disable student also contributes in difficulty of exploring and selecting the best subject of study.

Inclusively, disable student can normally choose the subject of study as like the normal people. There are some subjects of study that commonly was selected by Indonesian disable student that are: sociology, business, administration, law, library, computer and religion. Every single subject has unique characteristic and unique facility eg. Subject of study for disable students have complex correlation with histories background and their performance. Students who select computer should have a strong ability in mathematics and algorithm.

2.2. **Neural Network (NN)**

A Neural Network can be described as a “black box” that knows how to process inputs system to create useful outputs. The BPNN calculation is very complex and difficult to understand by using a mathematical model. Neural network copied the working system of biological nervous system as an example of the brain for processing the information. The goal of a back propagation neural network is to minimize the error which is indicated by mean square error (MSE). The other expert defines the neural network (NN) as a powerful data modeling tool that is able to capture and represent complex input/output relationships involving many factors. The advantage of NN tool is to recognize a lot of problems in the science area, medicine, military, financial, etc. to perform finishing tasks like the human brain. The legal NeuroSolutions website notes that NeuroSolutions is leading edge neural network development software that combines a modular, icon-based network design interface with an implementation of advanced genetic and learning algorithms. Neural network software is used to simulate research, build and apply artificial neural networks, biological neural networks and in some cases a wider array of adaptive systems. Many years worth of neural networks have been successfully applied to various data prediction, data classification
and data mining problems in wealth, military, financial areas, etc. Much NN software provides a graphical neural network development tool that enables the user to easily create a neural network model for the data experiment.

A neural network as “interconnected assembly of simple processing elements, units or nodes, whose functionality is loosely base on the animal neuron [4]. The processing ability of the network is stored in the interunit connection strengths, or weights, obtained by a process of adaptation to, or learning from, a set of training patterns”.

The most common neural network model is the multilayer perceptron (MLP). This type of neural network is known as a supervised network because it requires a desired output in order to learn. The goal of this type of network is to create a model that correctly maps the input to the output using historical data so that the model can then be used to produce the output when the desired output is unknown. The MLP and many other neural networks learn using an algorithm called ‘backpropagation’. With backpropagation neural network (BPNN), the input data is repeatedly presented to the neural network. With each presentation the output of the neural network is compared to the desired output and an error is computed. This error is then feedback (backpropagated) to the neural network and used to adjust the weights such that the error decreases with each iteration and the neural model gets increasingly closer to producing the desired output. This process is known as "training".

![BPNN flowchart](image)

**Figure 1:** Description of how the BPNN is working [5].

Backpropagation has been used since the 1980s to adjust the weights of the network. The principle of BPNN is calculating the error by taking the difference between the calculating result and the actual result, the error is fed back through the network and the weights are adjusted to minimize the error. Figure 1 shows the BPNN works to train the pairs of data set and the performance is indicated by comparison output and target as MSE function. The input – output data set of disable database is divided into 3 parts data as 70% for BPNN training, 20% for BPNN validation and 10% for BPNN test.

The following is an explanation of the steps of using NN software to process the NN module:

1. **Training - Data** is used in the neural network to learn the databases’ correlation.
2. **Cross Validation - Data** is used to evaluate the performance during the learning process to avoid over-training.
3. **Testing - Data** is used to evaluate the performance after the training is complete. Production - Input data to feed into the trained neural network to produce output information.

### III. RESEARCH METHODOLOGY

Complex correlation among academic background, personal experience, family background, subject of study and grade (studying performance) are very difficult to describe or to model in mathematic modeling. The condition encourages author to employ NN tool to select the best factor combination of subject of study and performance.

Figure 2 shows the flowchart of research steps. The research will be focused on identification factors of selecting the subject of study. Through extensive search of the literature, questioner and investigation on student performance, a number of socio-economic, physical, environmental, academic record, facility and other related factors that
are considered to have influence on the performance of a University student were identified. The histories background factor including the subject of study will be an input database and the academic performance will be an output database. The database will be used in the BPNN training process. The quality of the BPNN training and cross validation is depending on the NN topology and it will be controlled by mean square error (MSE) value. In this project, the MSE value for the training process should be less than 0.001 as limitation of the total number of the database.

To achieve the small MSE target, selecting the BPNN structure is to be an important stage in this project. The BPNN topology has special characteristics for the limitation of the database based on the design of experiment / Taguchi method [6]. The BPNN is structured as follow:

- BPNN working in one hidden layer
- 40 neurons in hidden layer
- Sigmoid and linier transfer function
- Delta-Bar-Delta learning rule
- Genetic Algorithm (GA) optimization

The randomization method is commonly used to initialize the network weights before training. In this case, genetic algorithm (GA) is employed to minimize fitness criteria (MSE) by BPNN weights adjustment. The main advantage of using GA is associated with its ability to automatically discover a new value of neural network parameters from the initial value. There are some GA parameters that are employed in this BPNN training:

- This study selected fitness convergence that the BPNN training will stop the evolution when the fitness is deemed as converged.
- The Roulette rule is employed to select the best chromosome based on proportionality to its rank.
- The initial values for learning rate and momentum are 0.5000 and 0.0166.
- Number of population is 50 chromosomes and epoch number for maximum 100.
- Initial network weight factor is 0.1074.
- Mutation probability is 0.01.
- Using heuristic crossover.
Finally, there are some output target in the research of NN tool for guiding new disable student candidate, the outputs are:

- Information of academic histories and family background from the disable students as input database.
- Information of study performance from the disable students correlated to their subject of study as output database.
- NN tool to guide the University management for helping new candidate disable student in selecting their subject of study.

IV. RESULTS

The NN database for disability students is created based on the information from the early survey and from the questioners. It contents of student age, average the mathematic score in senior high school, school background, parent education, subject of study at the University. All the factors ware mentioned above is to be an input database. The grade factor (student performance) is to be an output factor. The data is taken from disability student. The total of the data is 59 questioners which are coming from University of Brawijaya (UB), University of Gajah Mada (UGM) and UII Jogjakarta.

Table 1 explains all the input and output databases of disable student. The age factor is ranged from 18 to 25 years old. Mathematics score is the highest variance comparing to the other factors with $\sigma = 0.74$. School background for disable student before studying in the University is divided into two class for special high school for disability (SS) and senior high school (SHS). Parent education level involved junior high school (JHS), SHS, bachelor degree (BC) and master degree (MD). There are some subjects of study based on the data histories e.g. business, accounting, social science, religion, sociologic, etc. The last factor is grade or
student performance. As the varieties of student performance evaluation, simplifying method is employed with converting to scale 1 for poor performance, scale 2 for medium performance and scale 3 for good performance.

Table 1. Input – output database for performance of disable student

<table>
<thead>
<tr>
<th>No</th>
<th>Age</th>
<th>Mathematics</th>
<th>Higher Education</th>
<th>Parent Education</th>
<th>Subject of study at the University</th>
<th>Output Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>84</td>
<td>SHS</td>
<td>JHS</td>
<td>sociologic</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>8.3</td>
<td>SHS</td>
<td>BD</td>
<td>Accountant</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td>5.5</td>
<td>SS</td>
<td>MD</td>
<td>Social</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>8.8</td>
<td>SHS</td>
<td>SHS</td>
<td>Business</td>
<td>2</td>
</tr>
<tr>
<td>57</td>
<td>25</td>
<td>7</td>
<td>SHS</td>
<td>BD</td>
<td>Religion</td>
<td>3</td>
</tr>
<tr>
<td>58</td>
<td>23</td>
<td>6</td>
<td>SS</td>
<td>SHS</td>
<td>Social</td>
<td>3</td>
</tr>
<tr>
<td>59</td>
<td>24</td>
<td>7</td>
<td>SHS</td>
<td>BD</td>
<td>religion</td>
<td>2</td>
</tr>
</tbody>
</table>

Figure 3a and 3b shows the optimum BPNN training processes for the disable database. The training process involved 75% of the total number of database. The training process starts to convergence condition at the 14\textsuperscript{th} epoch and it stops to iteration at the 33\textsuperscript{th} epoch with an average MSE performance of 0.00258 and the best MSE performance of 0.000015. Test and cross validation was successfully created by 10\% and 15\% respectively of the total of the database.

Figure 3a. The best MSE for NN training with GA application, b. the average MSE for NN training with GA application

One sample test is used to validate the BPNN training process. Using input condition of mathematics score = 8, age = 18 years, higher education = SHS, parent education = bachelor degree and subject of studying is business will give student grade = 2.00276. It will give difference performance if selecting in the other of subject of study e.g. social science has performance = 3.0556, religion = 0.00255, sociologic = 2.00003, etc.

Every input factor has difference sensitivity level in student performance. Figure 4 shows the difference impact of increasing the student age to subject of study. The 18\textsuperscript{th} years old for disable student will give the best performance in social science with grade more than 3. It will decrease sharply to around 2 after 20\textsuperscript{th} years old.
IV. CONCLUSION

According to the BPNN training and validation result, the BPNN systems have worked well with the optimum MSE value = 0.000015. The research successfully builds an NN tool to select the best subject of study related to disable student performance. The further research suggestions are presented based on the experiences and the limitation facilities during working on this project. The future project could include:

- Increasing the total number of databases input – output can improve the training and validation of BPNN.

- Involving the other factors, such as: region, level of disability, etc. will give a complete information in the intelligent model

V. ACKNOWLEDGEMENT

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VI. REFERENCES