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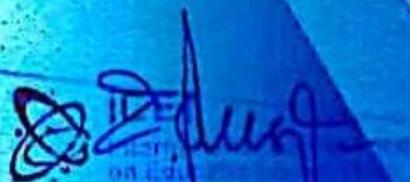
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# Teaching Science to University Students with Visual Impairment

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**Abstract**—The research aims to describe the implementation of measurement experiment student worksheet for a student with visual impairment based on braille code, adapting cylinders, adapting instruction, and adapting environment learning. The research design was a descriptive case study. The study conducted on the experience of one male student with visual impairment. The student has a great ambition to understand science concept, but with little support in the regular classroom. Findings show that students with visual impairments need adjusted instruction and environment accommodation in the classroom for better science learning. Moreover, students need instruction with braille code, audio, and more tactual, also technical skill to structure practical work.

**Keywords**—science; university students; visual impairment

## I. INTRODUCTION

Universitas Negeri Surabaya has received an Inclusive Campus Award in 2014 from Indonesia's ministry of education and culture. This award is intended to recognize the outstanding services for students with disabilities. To date, there are nearly 50 students with disabilities in Universitas Negeri Surabaya. Further, they should take the same subjects as other students. One of the compulsory subjects in Science. Indeed, for students with visual impairment, they might regard this course as the most challenging one, as it mostly discusses the abstract ideas or concepts [1].

Moreover, it is exacerbated by the fact that teaching Science is commonly based on visual instruction and hands-on activities. Indeed, students with total blind are not having visual input at all and some of them might need support in orientation and mobility. Thus, they another sense as the media to learn Science namely touching and hearing to learn Science. Most of the tutors in university and science teachers have a lack of experience in teaching students with visual impairment [2].

However, in teaching Science for students with total blind, several adjustments are essentials. That adjustment could be by using assistive technologies ranging from scanners, braille generating software, screen-reader software, speech synthesizers, braille printers, and embossers, and closed-circuit television [3]. Indeed,

Spungin and Ferrell [4] assert that teachers have multiple roles in designing learning and building learning engagement of the students. Moreover, students with visual impairment should have an equal chance in learning Science as other students by providing adjustments both on the learning environments and learning materials. Thus, to make Science accessible for them, teachers should be knowledgeable about their characters. Moreover, the importance of learners being taught with the appropriate skills and having access to tactile graphics, to ensure that they get the most out of materials presented to them [5].

Furthermore, tutor or lecturer should be responsible for understanding the learning characteristics of students with visual impairment to improve the participation and learning outcome of Science course for them. Nelson et al [6] find that some of the students with visual impairments consider their disabling condition as an advantage in studying organic chemistry. Students with total blind need the adjustments to increase the accessibility to do the experiments and exercises in the classroom so that they will be able to continue learning science at the post-secondary level so that they will be able to pursue a career either in technology, engineering, science, or mathematics professions [7].

Over the past three decades, computer-based and tactile adaptive technologies for chemistry laboratory have been developed. In the 1980s, Austin et al [8] created a device that able to verbally doing the pH reading, performed titrations, and analyzed gas chromatographic. Moreover, the successful students are predominantly self-taught and often overcome significant and practical barriers, mainly inaccessible course project and materials [9]. The process of designing an effective instructional and also the support team start with making sure that the key assistive technologies are ready, thus it makes all class meetings accessible, and also producing accessible course materials [10].

Sahin and Yorek [1] consider that science and mathematics education is accessible to fully sighted children, nevertheless, it is less accessible to students with visual impairment. Especially If many concepts are presented graphically, and could not be explored by touching as it puts across through visual observation. Physics subjects is a human context to develop students with

total blind skill in science process skill requires posing problems [11]. Students with visual impairment at formally inclusive class are not inclusive, as they generally sit and do not actively participate during the course and so that this kind of self-learning materials will help students with visual impairment to learn the subject and to engage in class discussions [12].

Indeed, in reality, many students with total blind are unable to participate in Science course in the mainstream setting because of the limited access to assistive technology and teachers' attitude. Thus, the aim of this study is describing the experience of one student with totally visual impairment by applying case study research design. He is taking the Science course on the same regular basis as the other students. Even though he has a great ambition to learn Science, he has limited access and support. Moreover, he considers the tutor as the primary source and explains that currently learning Science is mostly verbal. Hence, it is vital to understand the supporting factors to increase the students with total blind participation in learning Science.

## II. METHOD

The current study applied a 'case-focused study'. This is an individual case-study approach which supports the unique characteristics of the researcher [13]. This method was chosen because the author wanted to get in-depth explanations of behavioral problems in hands-on activities and answers from several questions. Moreover, Chen and Hoshower [14] assert that if the researcher will investigate one single thing, such as a person from a specific group or a single group, a single case study is the best choice. Further, a case study can also be defined as an exploration of a real-life, single bounded system (a case) or multiple bounded systems (cases) over time, by collecting the detailed in-depth data which involves many sources of information and the reports of a case description and also the case themes [15]. McMillan and Schumacher [13] explain a case study research method can be described as the comprehensive study of 'a single area', for example, 'an event, activity, event, individuals, or concepts'. Given this concept, case studies must collect large quantities of data so that the researcher can develop patterns of ideas, which will produce meaningful information on the single cases. In this study, even though findings are formulated from in-depth analysis of phenomena, they are not generalizable as they investigated a limited number of phenomena with characteristics of interest of the researcher. However, insights from this case studies will lead to wider research, that can be considered as more generalizable.

Data collection was done through a face-to-face interview and experiment involving only one participant, owing to his unique technical arguments in a science-related field – a field which few blind and partially sighted learners pursue in Universitas Negeri Surabaya, Indonesia. It should be noted that, since this was a small case study, the chance of many lecturers and students with visual impairment expressing heterogeneous views does exist. Moreover, the researcher urged that it is essential to conduct a follow-up telephonic interview to validate the participant's responses and comments which were recorded during the face-to-face interview. Data were presented in thematic sections, which arose from responses received from both the face-to-face interview and the follow-up interview. The data were

examined qualitatively for the analysis. The views of the student with visual impairment were sought on the visibility, benefits, and challenges of Science course in Universitas Negeri Surabaya.

The participant in this study was a 22-year-old man with total visual impairments who currently studying in Special Education Department in Universitas Negeri Surabaya. Even though he has 14 years' learning experience in a mainstream setting, He is still struggling to use visual stimuli to integrate information from the surrounding environment meaningfully. Moreover, the participant uses a white cane to assist him in navigating his way on guiding block.

## III. RESULTS AND DISCUSSION

### A. Material Adjustment

Students with visual impairments need laboratory procedure converted or adapted in Braille to access the information so that it will allow the student's participation during learning sessions in the classroom. Braille is a reading and writing system for students with visual impairments to gain information and learning instructions. The teacher of students with visual impairment determines the adaptation for instruments and learning tools for implementing practical work of measurement in Science. Material adaptation for volumetric measurements with markings calibrated to volume notched onto the graduated cylinders, providing tactile markers, and Braille labels used to identify the calibration volumes. Moreover, in Special Education Department of Universitas Negeri Surabaya, students with total visual impairment complete the written exams by listening to the oral question and answer it by typing the answers. Furthermore, during the mid-semester exam and assignment tutor will send the materials via e-mail and students will convert that material using the JAWS program so that they can understand the materials. JAWS will directly read aloud what is displayed on the computer screen. Further, it is also compatible with Microsoft Office suite, internet explorer, adobe acrobat reader, and many more applications that are used regularly in school. Graybill et al [16] state that more positive attitudes about science among students with visual impairment can be enhanced by implementing material adaptation in chemistry classes and laboratories, active participation and learning. This study also supports the approach of Bülbül [11] who describes that student's with visual impairment Science skills and discussed taking lab materials out of school and doing experiments more flexibly.

### B. Instructional Adjustment

#### 1) Small group setting

It is evident that the subject on this research was joining a lesson by being a member of a small group in which he could join the interaction with other students from the same course and one of them is his roommate. The topic in a small group is to arrange laboratory activities modification to measurement volume of liquid and solid materials use Erlenmeyer and graduated cylinder for students with visual impairment. The subject of this research received support from his classmates by helping him to gain concepts and information through reading aloud references, describing the figure, explaining visual element in an interactive

demonstration and doing a collaborative task. A small group discussion with the type of think-pair-share allowing the research subject to construct a concept, demonstrate the result discussion, present, and convert a worksheet to Braille code manually and engage in the topic discussion. According to Sahin et al [17], blind and partially sighted students need to be accommodated to help them to perform as well as their peers in Science learning. Students with visual impairment need a clear oral explanation from the teacher and peer group should avoid disturbing classroom or making noise during the discussion session.

## 2) One-to-one tutoring

The subject in this study needs one-to-one tutoring for assembling modification graduated cylinders with mark and braille code to seek help from the teacher and his friends to complete the assignment. Furthermore, in taking the exam in mid and end of semester participant need one-to-one tutoring to help reading aloud a problem or task and explaining the visual information, such as graphic and figure. Most of the one-to-one tutoring was conducted in a separate a room to minimize distractions. Moreover, this will allow the teacher to talk with the student while at the same time reading the content on the braille.

## C. Environmental Adjustment

Based on the interview with it can be known that he needs adaptations on classroom setting with tools for measurement practical work which are free from the barrier so that he can move safely and efficiently in the environment. Furthermore, he needs all of the materials to be labeled to ensure accessible and independence in practical work. Moreover, to achieve full participation in practical workroom should be organized through lay material to a worksheet. He might be independent in doing practical work through provides arranging environment through labeling tactile tool and collaborative working with his colleagues.

## IV. CONCLUSION

Teaching science which involves a practical work for students with total visual impairment can be done through the adjustment of the learning media with tactile and peers to provide more independent and active participation. Environmental adjustment, small discussion, and one to one tutoring lead more positive attitudes and confidence to learning science among students with total visual impairment. Environment for practical work measurement use Erlenmeyer and cylinder graduate to arrange through minimizing distraction and give appropriate adaptation for move safety and accessible work.

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