STEAM-deaf learning model assisted by rube goldberg machine for deaf student in junior special needs school

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Abstract. The 2013 curriculum has been applied in Special Needs School. STEAM can be taught in deaf classrooms using hands-on project for giving students experience working in cooperative team. This paper provides the research of STEAM-Deaf model learning and utilization of Rube Goldberg Machine (RGM). It is aimed to determines characteristic, effectiveness and practical of this model. The method uses Research and Development with single participant design. This research was conducted at SLB Ungaran. The result of research shows that the characteristic STEAM-Deaf consist of syntax with six phases namely observation, research, planning, application, analyze, and evaluation. The support system was STEAM lesson plans, RGM, and worksheet. The reaction system was teachers playing a role as a guide, facilitator, and motivator.

The instructional effect showed that the enhanced student’s understanding in cognitive aspect and growing students’ science creativity skill. The nurturant effect showed that students dare to do experiment, independent, and build good team work. The effectiveness of models’ to be analyze with effect size ($d$). The mean of deaf students’ understanding in cognitive $\geq 0.2$ with high criteria. The percentage of science creativity skill, with very good and good criteria. The practical results obtained a percentage average based on deaf student and teacher with practical criteria. Based on the result of this study, it can be concluded that STEAM-Deaf model learning with utilization of RGM is practical and effective for enhancing deaf student’s cognitive aspect and for growing their science creativity skill.

1. Introduction

Education is one strategy to enhance deaf students’ creativity and competency of life. Hearing impairment is an individual condition that has experienced the sense of hearing damage resulting in an impaired ability to recall, which covers the entire mild and moderate to severe gradation [1]. Although they may have hearing aids, deaf students can still have difficulty speaking. Thus, they require special education services to maximize existing capacity and ability, so they can interact with their surroundings.

Barriers experienced by deaf students can decrease their result in academic achievement. They can tend to be low. The general restrictiveness of deaf students, based on the observations in special school, are (1) the deaf student have low understanding of the vocabularies, (2) the difficulty understanding the new vocabularies which is abstract, (3) the speed of reading is low, (4) the understanding of linking the concept of learning with life activities is relatively low, (5) the ease to forget the material, (6) the preference of using visual means or objects. If the restrictiveness of the deaf in learning activities is not
given treatment, it will result in the inability of deaf to improve their potential and skills that will be useful in community life.

Special needs education which adapts to the conditions and needs of deaf student is very important. Special education is an education for students who have difficulty in following learning process because of physical, emotional, intellectual, social, and/or have the potential intelligence and special talents [2]. Now days, curriculum 2013 has been applied to special school with the aim to improve the quality of education, especially the learning process. However, the implementation of the curriculum still indicated some weakness which lead to the conclusion that educators and instructors should innovate to be able to create a learning circumstance that is able to guide students to develop the skills required so that they can compete in this millennial era [3].

In addition, many schools that handle deaf students are done simply without paying attention to personality conditions and adequate learning strategies. It can happen in special school that have implemented the curriculum at Indonesia (K-13), but have learning process’ still centered on the teacher, less supportive learning facilities including laboratory, and have yet to implement project-based learning. The issue of education for the deaf, not only relates to learning problems, but also to infrastructure and carrying capacity more specifically with the needs of deaf student. In addition, teachers need to pay attention to the characteristic and needs of deaf students, including sign language abilities.

Science process skills can be applied in student-centered learning process. The current paradigm learning model has changed from being teacher-centered to becoming student-centered learning [5]. One of the learning models that can be applied in the curriculum 2013 to develop process skills, be student-centered, and integrate is STEAM. Creativity, interdisciplinary, real-world, and problem/project-driven emphases, are central to STEAM and design as well [6]. STEAM is closely associated with project-based learning. One of which is a RGM project. Rube Goldberg (1883-1970) was an engineer who turned to be a cartoonist who drew incredible machines that completed simple tasks, such as turning off a light switch, in as complex a way as possible [7]. RGM principle is related to the concept of physics, including force and motion. In the stage of understanding STEAM and Rube Goldberg’s Invention, the related activities stimulate students’ academic curiosity and interest (A) and help them develop a positive attitude toward science, examine and analyze (S) Rube Goldberg’s Invention to learn its scientific (T) and mathematical (M) principles as well as engineering mechanism (E) [8].

2. Materials and Methods

2.1. Research Method
The method which was used is a Research and Development method (R & D) [9]. Result of this research is STEAM–Deaf Model of Learning.

2.2. Subject Research
This initial research is conducted at special needs school SLB Widya Bhakti Semarang. The trial research is conducted at SLB N Ungaran Semarang, especially deaf students. The number of trial research subjects was 3 students.

2.3. Analized of Data
After the learning material for the STEAM-Deaf model was constructed, it could analyze the results of deaf students baseline and intervention using the Cohen effect size equation with a single participant design. The equation is

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d = \frac{M_i - M_o}{SD_p \sqrt{\frac{1}{(1 - r)}}}
\]

The criteria effect size [10] is shown in Table 1.
### Table 1. Effect Size Criteria

| Interval       | Criteria |
|----------------|----------|
| d ≤ 0.2        | Small    |
| 0.2 <d ≤ 0.5   | Medium   |
| 0.5 <d ≤ 2.0   | High     |

3. Result and Discussion

3.1. Characteristics of STEAM-Deaf Learning Assisted by RGM

The learning model can be understood as a conceptual framework that describes and depicts systematic procedure, organizing learning experiences and learning to achieve the certain of objectives, and serves as a guide for lesson planning for teachers in implementing the learning activity [11]. The learning model has the basic elements, namely syntax, social systems, reaction systems, support systems, instructional effect, and nurturant effect [12].

Model STEAM-Deaf is a model of integration of science, technology, engineering, arts, and mathematics used in the classroom. It is aimed to improve cognitive learning; foster aspects of science process skills, centered on the deaf students; and provide direct experience in the learning process and linking of everyday life. The explanation elements of the STEAM-Deaf learning model assisted by RGM are syntax, the social system, the support system, the reaction system, the instructional effect, and the nurturant effect.

a. Syntax

Syntax includes the sequences of steps involved in the organization of the complete programmed of teaching [13]. STEAM-Deaf syntax model learning was examined and modified with models of social learning and behavioral systems by [12], the teaching model STEAM according to [8]. The results was the development of the syntax model which obtained the STEAM-Deaf consisting of six phases, namely observation, research, planning, application, analysis, and evaluation.

b. The Social System

The social system is related to the description of the interactive roles and relationship between the teacher and students, kind of norms that are observed and student behavior which is rewarded [13]. The social system that occur in this model is a fun collaborative and learning environment. The integration approach of the STEAM project is an interesting, exciting, and fun learning process [14]. A collaborative learning environment arise when deaf students in groups conducted RGM project creation.

c. The Support System

The support system is materials, tools, or a learning environment that supports learning [12]. The support system in the STEAM-Deaf learning model consist of the syllabus, lesson plans, RGM aids, student worksheets, and evaluation sheets. RGM media used in learning can be seen in Figure 1.

d. The Reaction System

In the STEAM-Deaf learning model assisted by RGM, teachers have role as mentor, facilitator and motivator. Teachers as mentor encouraged deaf students to explore the learning experience by providing teaching materials, and paying attention to the needs and limitations of the deaf students. Teachers as facilitators provided the facilities for learning resources, consisting of teaching materials, student work, and RGM props. Teachers as motivators give attention, encouragement, feedback, and engage students in the expected goals.
e. The Instructional Effect
The instructional effect that is focused in the STEAM-Deaf learning model assisted by RGM can improve the outcomes of the cognitive aspect and foster deaf students’ science creativity skill processing in science-physics subject. The mastery of this cognitive aspect refers to Bloom’s taxonomy including remembering, understanding, applying, and analyzing.
f. The Nurturant Effect
The nurturant effect showed that students dare to do experiment, be independent, and build good team working.

3.2. Practicality of STEAM-Deaf Learning Model Assisted by RGM
The result of practicality data was obtained from the response data of deaf teachers and students of 7th grade class at SLB N Ungaran, Semarang. Based on the practicality test the responses of the students were obtained scores of students with an average percentage of 81.25% with practical criteria and the percentage of responses from the teacher was 84.37% with a practical criteria.

According to the results of these datas based on questionnaire responses, the implications of this study are exciting for learning lectures. Use of visual aids could help the students’ understanding in material; help students be more creative, active, and think with a different viewpoint; find new ideas to implement materials; and train cooperation with another friend.

3.3. The Effectiveness of Model Deaf STEAM-aided RGM
The effectiveness of this model is derived from the cognitive learning and observation in science creativity skills in the stage of large-scale trials. Cognitive learning data outcomes are obtained from baseline and intervention. The result of baseline and interventions data’ were analized with the effect size equation. The result of analized show at Table 2.

Based on this analysed data, it obtained correlation value of “r” 0.78. It means that both datas (baseline and intervention) have high correlation. For getting the effect size value, it can be obtained with effect size Cohen’s equation “d”. The result showed that the enhancement of the learning aspect is high with the value of “d” at 1.93. Besides this, the result of the science creativity skill assessment from observing, each student with the code S-03, S-04, and S-05’ gave the students the percentages of 90.47%, 95.23%, and 76.19% with the respective criteria’ very good, very good, and good. There are different scores in the aspects of science creativity skill.

Student with the code S-04 obtained the higher percentage values than the other students. Obtaining a score of S-04 meets the maximum indicator except on aspects of interpreting, where S-04 only connects the observed results that not more than seven sub materials. In the aspect of science process skills, S-04 was dominant when it projected and fulfilled student worksheets. The personal
characteristics of S-04 is a severely deaf child who does not have a double disorder because he understands Indonesian Sign Language (BISINDO in Indonesia). S-04’s comprehended the material well, taking into account the teacher during teaching, his visualized example of applying the material well, the role of the current work practices performed well, test taking that is good, lack of forgetfulness, however, S-04 is less scrupulous in doing so.

**Table 2. Baseline and Invention Recapitulation**

| No | Student code | Baseline (B) | Intervention (I) | B   | I   | bi  |
|----|--------------|--------------|-----------------|-----|-----|-----|
| 1  | S-03         | 30           | 53.33           | -7.77| -8.89| 69.16|
| 2  | S-04         | 43.33        | 76.67           | 5.55 | 14.4 | 80.22|
| 3  | S-05         | 40           | 56.67           | 2.22 | -5.55| -12.34|
| M  |              | 37.77        | 62.22           |      |      |      |

* r_b = 0.78  
* SD_b = 5.60  
* SD_i = 10.30  
* d = 1.93

The student with the code S-03 is a deaf child. Based on the testimony of S-03 teachers, spelling is difficult when understanding words with more than two syllables. S-03 often interferes with the concentration of friends in the classroom by encouraging interaction; however, when teachers taught, S-03 gave attention pretty well, understood the SIBI sign language and understand BISINDO. S-03’s level of material mastery is not good and he is easily to forgetful. He needs mentoring teachers when filling out the student worksheets, and actively ask the teacher if he does not understand the spelling of words. The subject easily switches attention when a friend makes a joke.

The student S-05 is deaf student with hearing severe impairment, who communicates using sign language SIBI and BISINDO. The articulation is good enough. He does not have doubled disorder. The level of mastery of the material is good, but S-05 is more passive when practicing. He needs the assistance of a teacher at the time of filling out students' worksheets. But in the phase of analysis and evaluation, S-05 is more active by doing worksheets alternately with another friend. After using the RGM aids, students become more active and not easily bored in following the learning process. Students understand the material which is presented by teachers, and provide corrections to themselves and friends if a mistake is made in demonstrating the style materials [15].

The effective learning for deaf students’ has more emphasis on the problem that is often encountered and involves students directly to obtain learning experience [4]. The learning experience is closely related to skills that emphasizes abilities to think, work, have a scientific attitude and communicate. These skills are important aspects in life [2].

### 4. Conclusion

Based on this research, the product STEAM-Deaf (Science, Technology, Engineering, Arts, and Mathematics for Deaf Students) learning model assisted by Rube Goldberg Machine (RGM) which is devoted to 7th grade deaf students in Junior Special needs School was developed. The characteristic of the learning model consists of learning elements, such as (a) syntax, (b) support system, (c) the social system, (d) the reaction system, (e) the instructional effect, and (f) the nurturant effect.

The effectiveness of the STEAM-Deaf Model showed that students dare to do experiment, independent, and build good team work. The enhancement analyzed deaf students with effect size (d) the code S-03 is 0.53, S-04 is 1.96, and S-05 is 0.56 with high criteria for each student. Each student had a percentage of science creativity skill’ with the code S-03 (90.47%), S-04 (92.23%), S-05 (78.57%) with the criteria’ very good, and good.
The practical results are obtained a base average percentage of deaf students at 81.25% and teacher 84.37% with the criteria practical. Based on the result of this study, it can be concluded that the STEAM-Deaf model with learning and utilization of RGM practically and effectively enhance deaf student’s cognitive aspect and grew their science creativity skills.

References
[1] Perwitasari D A, Rusilowati A, Sujawara and Purwania A S A 2018 Adv. Soc. Sci. Educ. Humantit. Res. (ASSHER) 247 56
[2] Erryanti M R and Poedjistaeti P 2013 UNESA J. Chem. Educ. 2 (1) 51
[3] Abdurrahman 2018 J. Phys. Conf. Ser 1157 (2)
[4] Agustini D M 2017 J. Widia Ortodidakrika. 4 (6) 427
[5] Rusilowati A 2009 Prosiding Seminar Nasional Penelitian, Pendidikan, dan Penerapan MIPA. pp: 90-96
[6] Henriksen D 2017 The STEAM Journal. 3 (1) 1
[7] Jordan S and Pereira N 2009 School of Engineering Education Graduate Student Series. Paper 5. 14.1038.1
[8] Kim H 2016 Eurasia J. Math. Sci. Technol. Educ.12(7), 1925
[9] Borg WR, Gall J P and Gall M D 2010 Applying Educational Research 6th Edition (Boston: Pearson Education, Inc)
[10] Cohen J 1988 Statistical Power Analysis for the Behavioral Science (2nd ed) (Hillsdale, NJ: Lawrence Associates)
[11] Rusilowati A, Sulhadi, Purwania S A and Perwitasari D A 2020. Indones. J, Phys. Educ. 6(2) 1
[12] Joyce B and Weil M 2012 Models of Teaching (New Jersey: Prentice-Hall, Inc., Englewood Cliffs)
[13] Pateliya Y P 2013 RET Acad for Int J of Multidis Res (RAIJMR). 2 (2) 5
[14] Apriliana M R, Ridwan A, Hadinugraningsih T and Rahmawati Y 2018 J Ris Pendidik Kim. 8 (2) 42
[15] Asrori A W 2017 J. Widia Ortodidaktica. 4 (6) 361