CHAPTER V
CONCLUSION, IMPLICATION, AND RECOMMENDATION

A. Conclusion

The research on developing STEM-based workbook on lever system in human body implementation has been conducted systematically following the applicable stage of Research and Development method, based on the research result and analysis it is acquired some conclusions as follows:

1. The development of this STEM-based workbook has been developed through the following stages; collection of research information, create preliminary product, preliminary field testing, revision, main field implementation, and final revision. The development of workbook was done by constructing outline design, expert judgement, and readability test. As the result of final revision, a new structure of STEM-based workbook has encountered. A STEM-based workbook shall have basic concept materials, exploring cases, define problem, propose solution, design solution, construct product, test product, re-design, and reflection. STEM-based workbook has differences on its activity, a process of exploring ideas, drawing pre and post design, and testing the product requirements that have become the main part of the workbook.
2. The implementation of STEM-based workbook on lever system in human body is capable to improve students' STEM competencies, it can be proven by students' result on some competencies of STEM. Students' knowledge understanding is improving which can be seen from the normalized gain (<g>) score is 0.41 and categorized as medium improvement, students' problem solving skill is also improving where it obtained a medium improvement with normalized gain as much as 0.45. Innovative abilities also encountered an improvement, the workbook analysis obtained a higher score where functioning product shown the highest score. Last, students' responsibility is keep improving day by day, students' effort gain the highest score it means that the students become more responsible after implementation of STEM-based workbook.

3. The observation of students' designing skill has resulted a highest score on prototype process it means that students can visualize the product very well, while the lowest score is from ideate process in learning session, it defines that students quite hard explaining the product orally but they can explain better in their workbook. Based on the workbook, a pre design mostly students design a quite impossible product to crack the egg with sophisticated technology and it was not a lever system while at the end of the learning, most students design an improved egg cracker that they have made, whether the one that is made by the factory or the one that they create and they can explain the lever system on it.
4. The respond of students towards STEM-based workbook on lever system in human body implementation, it shows positive respond towards STEM based workbook in all indicators; improving students' knowledge understanding, improving students' problem solving skill, improve students' innovative abilities and more responsible, stimulating students' designing skill, and the effectiveness of STEM-based workbook implementation. The highest score is obtained by stimulating students' designing skill, it means that most of students agree that by doing the STEM-based workbook it makes the students able to design a solution on real world problem.

B. Implication

The development STEM-based workbook on lever system in human body can be implemented in the real learning process at class that will apply STEM education on school as an innovation in learning materials. The research of development of STEM-based workbook on simple machine in human body has been proved as one of instructional materials that can improve students' STEM competencies in terms of knowledge understanding, problem solving skill, innovative abilities, even responsibility value as well as designing skill.

The instructional materials that is used in this research has been validated by expert lecturers in STEM education, some STEM teachers, and 30 students on 9 grade students in an international private school and being revised based on their

suggestion and test result. The development of STEM-based workbook in this research can be refereed as a framework for STEM-based workbook for another science or mathematics concept.

C. Recommendation

Based on the findings of the research that has been conducted and concluded, there are several recommendations that necessary to be conveyed by the researchers, some of them are:

1. In developing STEM-based workbook, the making of outline must be stated very clear, what aspects that will be exist in the workbook must be defined explicitly. Stating the indicators of learning inside the workbook is preferred.
2. The structure of STEM-based workbook on lever system in human body can be refereed as a framework for STEM-based workbook for another science or mathematics concept at schools.
3. Before designing a STEM-based workbook, teacher ought to adapt the learning with characteristics of students, school curriculum, subject matter appropriateness, learning objectives, school environment, and facilities, so that the STEM activity can run smoothly and not burden the students.
4. The instrument for readability to the expert, the range of easiness or hardness option should be more varied. Not only easy and hard but also should cover very easy, precise, and very hard.
5. Realizing that doing a STEM project requires sufficient time, teacher must be thorough in determining time allocation. Whether time for preparing the STEM-based workbook for teacher as well as finishing the STEM activity for students, so that all students can finish STEM activity optimally.
6. It is necessary to insert some concept of the subject in the beginning of STEM activity to avoid misunderstanding. Teacher also needs to make sure that all students are participating and work together in group to do the STEM activity.
7. At the end of the lesson, it is much better for students to do the presentation, it will make another students find out other groups' problem that they encountered during finishing STEM project.

8. During the evaluation stage, teacher also have to make sure that all students understand about the concept given by checking their knowledge at least orally, teacher also need to guide students in the whole STEM learning.
9. To other researcher who also have the same interest about STEM-based workbook and STEM learning, it is most recommended to develop the research wider in term of research variable, subject matter, science or mathematics concepts, and the lesson plan.
10. One of the specialties of STEM-based workbook is providing space for students to design their solution, it is much better if teacher use it as one of assessment and analyze students' way of thinking through their design on the workbook.
11. Workbook is one of instructional material that is recommended for implementing STEM learning at class, other researcher can try to develop any other instructional materials, or compare it with STEM-based workbook and check its effectiveness from students' accomplishment.