学位論文の要旨（論文の内容の要旨）
Summary of the Dissertation (Summary of Dissertation Contents)

論　文　題　目
Dissertation title

Research towards a Principle for the Statistics Curriculum in Japan from the Perspective of Context

広 島 大 学 大 学 院 国 際 協 力 研 究 科
Graduate School for International Development and Cooperation, Hiroshima University

博士課程後期　　　　教育文化専攻
Doctoral Program　　Division of Educational Development and Cultural and Regional Studies

学生番号　　　　　　D146383
Student ID No.

氏　　　名　　　　　　HIROTO FUKUDA　　　　　　　　　□
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The world around us is rapidly transforming from determinism to indeterminism (Popper, 1982). 'Information' and 'data' symbolise the present and future of this society. Thus, the acquisition of statistical literacy is indispensable for students to discern and use essential information and data from the large amounts of information and data that they will encounter in day-to-day life. Under this situation, several studies on method knowledge, which refers to learning how to handle information and data, have been accumulated in statistics education research (e.g., Wild & Pfannkuch, 1999). Nevertheless, some issues remain unresolved in this research field, and highlight two features ('the purpose is problem solving' and 'data are used in inquiry') related to method knowledge.

Regarding the former ('the purpose is problem solving'), the current society presents a complexity of information that extends far beyond the simplification or idealisation of problems in the real world (Hirabayashi, 2001). Therefore, it is important to clarify the problem to be solved before undertaking problem solving. A deeper study of the problem is still required, although research has been conducted for the Problem stage in the PPDAC cycle. PPDAC stands for the steps of Problem, Plan, Data, Analysis, and Conclusion (Wild & Pfannkuch, 1999). Regarding the latter ('data are used in inquiry'), data are certainly necessary in inquiry process. Thus, determining the kind of data to be collected for inquiries has important educational significance. This is the Plan part of the PPDAC cycle. Based on the above, the issues of what is a problem and what kind of data must be collected via statistical inquiry have not been adequately clarified yet. This is the problem statement in this research.

Statistics education deals with this statistical inquiry and thus problem and data. However, statistics education in Japan is currently being planned to shift from content knowledge to method knowledge, but there are no consistent and common principles from elementary education to upper secondary education regarding the problem and data in statistical inquiry. Today, everyone can use the Internet and obtain a variety of information and data by searching to find out solutions to the problems which they encounter in day-to-day life. Since the problems are always embedded in a certain 'context', it is essential to discuss the context to be treated even in statistics education. From these considerations, the objective of this research is to develop a principle for the statistics curriculum in Japan, paying attention to context. To attain the objective, the author formulates the following five research questions (RQs):

RQ1：What is context in statistics education? What is the current status of statistics education research on context?

RQ2：What are the characteristics and issues pertaining to context in current Japanese statistics education?

RQ3：What is the framework to conduct statistical inquiry that takes the context into account?

RQ4：Is the framework developed in RQ3 valid?

RQ5：What is a principle for the statistics curriculum in Japan focusing on context?

For RQ1, context in this research means the concrete situations of problems existing in the real world and is referred as the data-context: the real-world situation from which the problem arose (Pfannkuch, 2011, p. 28). The literature review revealed that statistics education research on context is insufficient and still needs to be studied.

For RQ2, the author conducted the textbook comparison between Japan and New Zealand. This is because the intention of statistics education in New Zealand is to teach and learn method knowledge for statistical inquiry, and this is consistent with the direction required for future statistics education in Japan. The comparison results revealed the characteristic of how context is treated in Japanese statistics education, namely, efforts are made to incorporate context in the problem itself. However, it cannot be said that context is included in the inquiry and answer when posing the problem. Moreover, there is a bias into types of contexts in Japanese statistics education: sports, weather, and tests. Comparatively, the observation of educational practices in New Zealand revealed that statistics education handles not only data but also contextual thinking. Contextual thinking here refers to emergence of another context when thinking about a specific context. To broaden　an idea of contexts and acquire contextual thinking, students must acquire knowledge on various disciplines and use an interdisciplinary approach. This is one of the current issues in statistics education worldwide.

For RQ3, in order to handle these issues, this research established emergent hypothesis modelling as the framework to conduct statistical inquiry that takes the context into account. Emergent hypothesis modelling shows a series of processes, which requires two models: the hypothesis model-for (a hypothetical answer based on students' anticipation of the question) and the hypothesis model-of (a concrete premise of the problem-solving process based on search). In this modelling, the hypothesis model concretely emerges at the first stage of the statistical inquiry process. The core of emergent hypothesis modelling is the formation of hypotheses through contextual thinking. Therefore, emergent hypothesis modelling constructs the statistical inquiry cycle in the context world.

For RQ4, based on the above considerations, the author developed a teaching unit 'The Ecology of the Environment and Causal Relationships'. The author then conducted the teaching experiment based on this teaching unit and analysed it from the viewpoint of case study method. The causal inquiry resulted in both the beginnings of statistical literacy at the critical/mathematical level and the refinement of the hypothesis model-of based on the hypothesis model-for by emergent hypothesis modelling. Thus, the author could show empirically that emergent hypothesis modelling is valid.

For RQ5, the author developed a principle in order to not only pay attention to the PP stage but also conduct a survey of that stage within the PPDAC cycle based on the two theories, integrated modelling approach (IMA) (Manor Braham & Ben-Zvi, 2017) and the reasoning with informal statistical models and modelling (RISM) (Dvir & Ben-Zvi, 2018). The shuttling model among the five worlds is proposed as shown in the figure. This model involves the emergent hypothesis modelling cycle, integrates IMA and RISM, and represents the whole statistical inquiry process. This model is common to all types of schools and can function as a normative model for the whole statistical inquiry process. Therefore, this model can serve as a principle for the statistics curriculum in Japan from the viewpoint of context. Finally, the author summarises the principle as the conclusion of this research: Statistical inquiry requires attention to the five worlds (phenomenon, context, data, model, and conjecture worlds) and the interconnections among them.
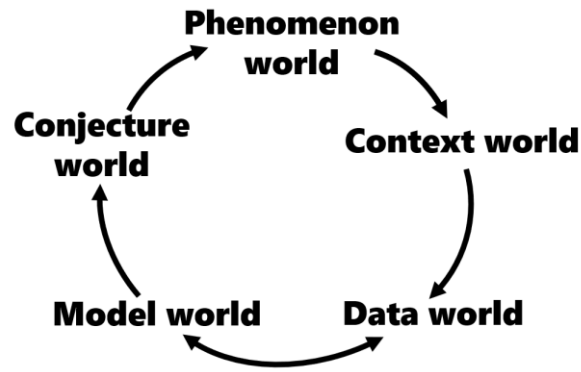
Figure. Cyclic shuttling between five worlds in statistical inquiry

This research targeted at developing a principle for the statistics curriculum in Japan. The findings are relevant to statistics education in Japan since it seeks to convert the teaching and learning of content knowledge into that of method knowledge. However, this is not only a concern specific to Japan. Competency-based statistics education is required in all countries (cf. Wild, Pfannkuch, Regan, & Horton, 2011). Thus, the findings are also applicable to some extent to statistics education worldwide. This research can contribute to the positioning and treatment of context in competency-based statistics education as the international standard. These are the significances of this research and its implications for statistics education.

One of the potential research limitations is that although it considered method knowledge in statistics education in detail, the author was unable to take content knowledge into consideration to any great extent. This requires that the inquiry be conducted using technology based on big data. Since Japanese statistics education in the future will place greater emphasis on inferential statistics, a future statistical inquiry should use big data and technology in an integrated way. Thus, future research can explore how to realise statistical inquiry using big data and ICT (Information and Communication Technology) and thus how to equip teachers with such usage of technology.

備考　論文の要旨はＡ４判用紙を使用し，4,000字以内とする。ただし，英文の場合は1,500語以内とする。

Remark: The summary of the dissertation should be written on A4-size pages and should not exceed 4,000 Japanese characters. When written in English, it should not exceed 1,500 words.