THE THIRD WAVE PROJECT

STUDY 5: THE VALUES ALIGNMENT STUDY

(2020 UPDATED VERSION)

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CHAPTER 1: INTRODUCTION

1.1. Context of Study

Teaching and learning mathematics is a social process. Every student is an individual, and every class has its unique attributes. Thus, for a teacher, it is one thing knowing all the relevant cognitive learning theories, planning approaches, teaching strategies and assessment modes, but it is another thing altogether being able to teach well such that students learn effectively. After all, the social aspect of the teaching environment plays a key role in facilitating teaching and learning.

Specifically, what the teacher considers important in their teaching, and what each student considers important in their learning, mediate the quality of pedagogical interactions between teacher and students, and amongst students themselves. For any teacher who values *collaboration*, say, any best intention that had been put into lesson planning would not be brought to bear if their students value *independent work* or *competition* instead and the teacher fails to respond to this value difference in the lesson planning and execution.

The assumption that is being made here is that teacher effectiveness is very much a function of a teacher's capability to recognize and respond to any difference between teacher and students' valuing. This teacher capability is concerned with aligning the different valuing that are espoused in the classroom interactions, so that intended pedagogical goals may be achieved in a productive manner. Values alignment does not necessarily mean that any one individual's valuing is embraced at the expense of the others which are different and which might be in conflict. Rather, values alignment is often concerned with a middle-path solution in which all or some parties are further guided by the valuing of some other attributes, resulting in a harmonious relationship between and amongst the teacher and students. What values alignment might look like exactly is unknown and is one of the objectives of this study. The belief here, however, is that this is why effective teachers are able to facilitate learning well across different groups of students. That is, these teachers respond to the differences between what they value and what their students value by orchestrating values alignment in the classroom, such that teaching and learning can proceed in a harmonious manner.

Values alignment has also been recently found to be a factor in enhancing students' self-esteem (Benish-Weisman, Daniel, & McDonald, 2020).

This is a professional craft which is not widely studied and understood so far. The design of this current research study is to thus allow us to document this important professional skill, in a context where many maths classrooms around the world are characterized by student disengagement. In other words, might empowering teachers to be better at achieving values alignment bring about more commitment by students to dedicate themselves to learning a subject that is important to living and thriving in the current era of the Fourth Industrial Revolution?

The Values Alignment Study constitutes Study #5 in the Third Wave Project. The Third Wave Project was set up in 2008 to support a community of mathematics education researchers who are working on studies which focus on values/valuing as variable. While most if not all earlier studies on values/valuing had focussed on the assessment of what students or teachers value in mathematics education (see, for examples, Böckmann & Schukajlow, 2018; Zhang et al, 2016), this current study pushes the research agenda: the mapping of teachers' values alignment strategies / approaches will have direct implications on how we can better design and deliver pre-service and in-service teacher education programs.

1.2. Research Questions

Specifically, this research study aims to respond to the following research questions:

1. What is the nature of value differences in the mathematics classroom?
2. How do mathematics teachers respond to value difference situations in their professional practice?
3. What teacher strategies have been effective in achieving values alignment?

It is useful to note that the current research study does not reject all that we know about facilitating mathematics pedagogy, which is almost all based on cognitive and affective perspectives. Rather, it represents one way in which the conative aspect of pedagogy, represented here by the construct of valuing (see Seah, 2019), might support existing pre-service teacher education and in-service professional development programs.

1.3. Significance and Innovation of Study

The current study is significant and innovative in that it is expected to bridge a crucial gap in teacher professional practice, not just in mathematics but across all school subjects. This gap, which comes about when teachers and their students value different attributes of the pedagogical process in classroom interactions, is not fully understood and thus not effectively dealt with from cognitive and affective perspectives. Yet, value difference situations create barriers to effective (mathematics) teaching and learning, when one's valuing is perceived to be under threat. Through the conduct of this study, an understanding of how teachers achieve values alignment would provide us with key knowledge to better support teacher development.

In the process of conducting this research study, we will also design, validate, and produce a culturally-sensitive, user-friendly and efficient online survey instrument with which value difference situations in the mathematics classroom can be identified. Such an assessment tool has not existed before, and it is expected that the online tool can be adapted by teachers and educators to map out the status of value differences in any class in an efficient manner.

This study is also significant in that there will be a large number of student participants and their teachers across the participating mathematics education systems. This means that we will have a rich databank with which detailed analyses can be conducted to better understand how cultural differences might mediate values alignment strategies in different mathematics education systems.

CHAPTER 2: RESEARCH DESIGN

2.1. International Collaborative Research

This research study will be conducted in the form of an international collaborative research, to be led by the Leading Investigator of the Australian team, and coordinated by a team made up of Leading Investigators of teams representing other mathematics education systems.

The roles of the Study Leader will include the

- conceptualisation - and its subsequent finetuning – of the research study,
- setting up of the international research team,
- coordination of communication amongst members of the international research team,
- coordination of the conduct of the study across different cultures,
- coordination of the synthesis and analysis of research findings from different cultures, and
- coordination of the dissemination of the research findings to both the academic and practitioner communities.

Each participating research team will be represented by a Leading Investigator. This person's roles will include the:

- contribution to the conceptualisation of the research study,
- customisation of the research design in ways which take into account the sociocultural features of his/her research sites, and which reflects the cross-cultural nature of this Study,
- setting up of the local research team,
- coordination of the conduct of the study within his/her nation / region,
- contribution to the synthesis and analysis of research findings from different nations / regions,
- dissemination of the research findings to both the academic and practitioner communities in his/her own nation / region, and
- contribution to the dissemination of composite research findings through different academic channels.

It is expected that the Study Leader and Lead Investigators will secure for themselves the relevant financial support for the research activities under their respective responsibilities.

2.2. Research Personnel

Role	Name	Institution
Study Leader	Wee Tiong SEAH	The University of Melbourne, Australia
Lead Investigator (Australia)	Penelope KALOGEROPOULOS	Monash University, Australia

Lead Investigator (mainland China)	Heng Jun TANG	Zhejiang Normal University, China
Lead Investigator (Ghana)	Ernest Kofi DAVIS	University of Cape Coast, Ghana
Lead Investigator (Japan)	Chikara KINONE	University of Miyazaki, Japan
Lead Investigator (Korea)	Jeong Suk PANG	Korea National University of Education, Korea
Lead Investigator (Nepal)	Ram PANTHI	Tribhuvan University, Nepal
Lead Investigator (New Zealand)	Jodie HUNTER	Massey University, New Zealand
Lead Investigator (Portugal)	Ana Isabel SILVESTRE	Universidade de Lisboa, Portugal

2.3. Research Approach

This is a cross-sectional study. Given the descriptive nature of the study design, with no 'treatment' being administered to participants, and given that we do not yet know what the nature of value differences or values alignment strategies, qualitative data will be collected. Yet, the need to map out a range of teacher values alignment strategies has meant that data need to be collected from a large pool of participants. As such, the qualitative text-based data will be quantified to facilitate numerical manipulation and data analysis.

As in all research studies, the research approach needs to be culturally-sensitive, not least due to the construction of a questionnaire which needs to remain valid and reliable when administered across different cultures in different languages. The formation of local research teams led by a local Lead Investigator represents an attempt in this direction. The involvement of these Lead Investigators (and possibly their respective research team members) will be encouraged at all stages of the study. Face-to-face meetings for the Lead Investigators will be organised to facilitate communication and deepen mutual understandings. This should not only enhance the methodological validity and reliability, but also respect the cultural sovereignty of all participants and the cultures they represent .

2.4. Research Participants

Data from each participating mathematics education system will be sourced from

- at least 300 11-year-old students
- at least 300 15-year-old students

across a variety of learning and educational contexts. These contexts are expected to include a spread of at least the following:

- student gender
- school system (government/state vs independent/private vs religious)
- school type (single-sex vs co-educational)
- school location (urban vs rural city vs rural)

In addition, to broaden the scope of the data sources, each research team is expected to select participants in such a way as to maximise the distribution of the following factors, if applicable:

- home language spoken
- students' home cultures
- school medium of instruction for mathematics

The selection and enlistment of student participants for the study will adhere strictly to the 'research with humans' ethics guidelines currently in force in the respective education systems.

2.5. Questionnaire design

A teacher questionnaire and a student questionnaire will be constructed in the English language, aimed at eliciting what teachers and their students value respectively during mathematics lessons, and how they respond to perceived value differences. These will be constructed using the SurveyMonkey software, to facilitate online administration. A hardcopy version of these questionnaires is presented in the Appendix. Note, however, that in generating the hardcopy version from the online website, the software omits choices that are visible in the online version which serve to facilitate respondents' choices.

For each questionnaire, other than a section which documents student respondents' demographic and personal information, there will be two other sections featuring open-ended items. One of these explore what respondents value in mathematics education. The other section explores respondents' perceptions of value differences in their mathematics lessons.

The draft versions of the questionnaires will be made available to all Lead Investigators for appraisal. Particular attention during discussions will be paid to the optimisation of the following factors:

- check against ambiguous and unclear items, to enhance the instrument reliability,
- metric equivalence of items, to ensure that the same concepts are being measured amongst the different mathematics education systems,
- meaningfulness of item content to each mathematics education system,
- language validity of the questionnaire across the different languages (through back translations), to ensure that the same concepts are being measured amongst the different mathematics education systems

Pilot-testing of the questionnaire in each mathematics education system by the respective research team will further seek to optimise the survey instrument's validity and reliability measures. In particular, calculations for Cronbach's coefficient alpha (Cronbach, 1984) and/or the Spearman-Brown formula will be made to enhance instrument reliability.

2.6. Data Collection

Data for this study will be collected via the use of an online questionnaire, although paper copies will also be an alternative format for respondents without ready access to the internet (such as in Ghana). The choice to adopt online technologies to gather questionnaire data was not only borne out of considerations to optimise efficiency and accuracy (e.g. doing away with the need for human data entry), but more importantly, to harness the capacity of computer technology to optimise the quality of the data collected.

In view of the student participant characteristics listed in Section 2.4, it is expected that sampling of the student participants will be achieve through stratified probability sampling of schools.

2.7. Data Analysis

A codebook and a data spreadsheet template will be created collaboratively with the Lead Investigators to analyse the questionnaire responses. The latter will be based on the spreadsheet generated by the SurveyMonkey software.

The data analysis process is outlined below, for consultation and discussion. The Japanese team is using this process when they work with their data. Kindly refer to the attached paper in Appendix 2 (Kinone, Soeda, & Watanabe, in print) written by our Japanese team, and which have been submitted to – and accepted by – a Japanese research journal. Our Japanese team leader, Kinone sensei, has also kindly translated the 20+ pages into the English language for us – this English translated version is attached here as Appendix 3.

The following will only be a sketch of the *first level* analysis process; as such, each research team is encouraged to expand on these steps, and to describe each step in a more detailed manner, when they are preparing their own reporting and dissemination.

- Download raw data spreadsheet from SurveyMonkey website after the questionnaire completion period is over.
    - (SurveyMonkey's new policy may make this hard to do, in which case Wee Tiong can download your raw data file and email you)
- 'Clean' the raw data
- Match each teacher questionnaire with their student questionnaires, so that we can have questionnaire responses from different individual classes.
- Analyse (manually or with the assistance of relevant software) the responses, identifying values through successive levels of abstraction, such as through asking 'why'.
- It is advisable to 'allocate' the teacher and student values to existing value frameworks, such as Bishop's (1988) 6 mathematical values and Seah's (1999) proposed maths educational values (as used by the Japanese team), while keeping an eye out – and allowing – for additional value categories which might not have been accounted for by the chosen value frameworks. Given that the objective of this Study is in the identification of value differences, the choice of different value frameworks by different research teams does not matter too much, as long as the same framework is applied to both teacher and student data.
- Comparisons may be made along the following lines, for examples:
    - General opinions on (teaching and) learning

      Teacher questionnaire Items 18-19 vs Student questionnaire Item 26
    - Personal opinions on (teaching and) learning

      Teacher questionnaire Items 20-21 vs Student questionnaire Item 27
    - Personal experiences with value differences

      Teacher questionnaire Items 22-34 vs Student questionnaire Items 28-32

2.8. Dissemination of Research Findings

It is expected that local and international dissemination of results and findings will be ongoing, with a mix of individual country and cross-cultural reports. In addition, each Lead Investigator is encouraged to propose and to present different levels of the research findings to the local professional community, through professional conferences and professional journals, including in languages other than English.

2.9. Research Timeline

Date	Event	Location & Personnel
2018 - 2020	Conceptualisation of Study 3	Study Leader Lead Investigators
	Formation of International Research Team	Study Leader Lead Investigators
	Drafting of Teacher and Student Questionnaires	Study Leader
	Appraisal of draft questionnaires	Study Leader Lead Investigators
Ongoing	Data collection and data analysis	Lead Investigators
	Dissemination and reporting by individual research teams	Lead Investigators
2021	Cross-cultural analysis	Study Leader Lead Investigators

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APPENDIX 1: QUESTIONNAIRES

The Third Wave Project
Study 5: The Values Alignment Study

Teacher Questionnaire
(vers 4 sample)

Dear teacher,

· There are no right or wrong answers to the questions in this survey.
Since everyone is different, it is important that your responses reflect your personal views.

· Your responses will be kept confidential.
Nobody except the researchers will have access to your anonymous responses.

· Please respond to all items.

· Thank you for your time!

The Values Alignment Study (teacher questionnaire) [vers 4 sample]

Section A: Tell us a bit about yourself

1. I am currently teaching in:
(Please select one)

2. My school is located in this city/town/suburb/village:

3. My school is a:
(Please select one)

4. My school is

5. In my class, maths is taught in this language:

6. At home, I speak mainly this language:

7. My ethnicity is:
(Please select one)

8. My country of birth is:

9. If you were born overseas, when did you come to your current country?

10. My father's country of birth is:

11. My mother's country of birth is:

12. My age is:
(Select one)

13. I am

- male
- female
- (prefer not to say)

14. I have been teaching mathematics and/or other subjects in schools for:
(Please select one)

15. I feel confident teaching mathematics.

- Disagree a lot
- Disagree a little
- Agree a little
- Agree a lot.

16. I was trained to teach mathematics during my teacher education program.

- Disagree
- Agree

17. For my mathematics class(es) which took part in this research study, the grade/year level(s) is/are:

Section B: What are very important to you

Example

Question: When choosing a new mobile phone, what do you think are very important to you?

Responses:

Screen size. A big screen size is impt to me because I work on my phone a lot.

Weight. It is hard to walk around with a heavy phone in the pocket.

Connectivity. A USB slot would be my dream. Transfers file efficiently.

18. What do you think are very important when *learning mathematics*?
(Write up to three things which you think are very important)

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19. What do you think are very important when *teaching mathematics*?
(Write up to three things which you think are very important)

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Think about any two maths classes you teach this year.
Let's call them Class A and Class B.

Class A

20. Grade level of Class A:

21. What do you think are very important to your students in Class A with regards to learning mathematics well?

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Sometimes we come across situations when what is very important to you may not be regarded as very important by your students. Or, what is very important to your students may not be very important to you.
Recall one such learning / teaching situation which took place in Class A.
(Take your time to think of one)

22. What was the learning / teaching situation like?

23. What did you and/or your students do to try to resolve the situation?

24. Is the situation still a part of your teaching life?

25. How has this situation affected your mathematics teaching in general, in Class A and beyond?

Class B

26. Grade level of Class B:

27. In what ways are Class A and Class B similar, and how are they different?

28. What do you think are very important to your students in Class B with regards to learning mathematics well?

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Sometimes we come across situations when what is very important to you may not be regarded as very important by your students. Or, what is very important to your students may not be very important to you.
Recall one such learning / teaching situation which took place in Class B.
(Take your time to think of one)

29. What was the learning / teaching situation like?

30. What did you and/or your students do to try to resolve the situation?

31. Is the situation still a part of your teaching life?

32. How has this situation affected your mathematics teaching in general, in Class B and beyond?

33. If you are interested to be kept updated with the findings of this research study, please provide your contact details below.

Name	
School	
Email Address	
Phone Number	

34. If you agree to be contacted by the researchers in the event that clarification of your responses here is needed, please provide your contact details below

Name	
School	
Email Address	
Phone Number	

Thank you for your participation!

The Third Wave Project
Study 5: The Values Alignment Study

Student Questionnaire
(vers 4 sample)

Dear student,

· There are no right or wrong answers to the questions in this survey.
Since everyone is different, it is important that your responses reflect your personal views.

· Your responses will be kept confidential.
Your parents, principal, teacher and friends will not be able to read what you write.

· Please respond to all items.

· Thank you for your time!

The Values Alignment Study (student questionnaire) [vers 4 sample]

Section A: Tell us a bit about yourself

1. I am currently studying in:
(Please select one)

2. My school is located in this city/town/suburb/village:

3. My school is a (please select one)

4. My school is

5. In my class, maths is taught in this language:

6. At home, I speak mainly this language:

7. My ethnicity is:
(Please select one)

8. My country of birth is:

9. If you were born overseas, when did you come to your current country?

10. My father's country of birth is:

11. My mother's country of birth is:

12. My age is:
(Select one)

13. My grade/year level at school is:

14. I am

- male
- female
- (prefer not to say)

15. I think learning mathematics will help me in my daily life.

- Disagree a lot
- Disagree a little
- Agree a little
- Agree a lot

16. Mathematics will assist with my learning of other school subjects.

- Disagree a lot
- Disagree a little
- Agree a little
- Agree a lot

17. I need to do well in mathematics to get into the college or university of my choice.

- Disagree a lot
- Disagree a little
- Agree a little
- Agree a lot

18. I need to do well in mathematics to get the job I want.

- ◯ Disagree a lot
- ◯ Disagree a little
- ◯ Agree a little
- ◯ Agree a lot

19. I would like a job that involves using mathematics.

- ◯ Disagree a lot
- ◯ Disagree a little
- ◯ Agree a little
- ◯ Agree a lot

20. It is important to learn about mathematics to get ahead in the world

- ◯ Disagree a lot
- ◯ Disagree a little
- ◯ Agree a little
- ◯ Agree a lot

21. My parents think that it is important that I do well in mathematics

- ◯ Disagree a lot
- ◯ Disagree a little
- ◯ Agree a little
- ◯ Agree a lot

22. My family discusses mathematics at home.

- ◯ Disagree a lot
- ◯ Disagree a little
- ◯ Agree a little
- ◯ Agree a lot

23. My parents give me support (e.g. explanations, employing a private tutor) when completing my maths homework/revision.

- ◯ Disagree a lot
- ◯ Disagree a little
- ◯ Agree a little
- ◯ Agree a lot

24. The nature of the out-of-school maths support I have (e.g. home tuition, weekend school, etc) is

- ◯ revising what has been taught in class.
- ◯ learning about topics that will be taught soon in class.
- ◯ both of the above
- ◯ not applicable: I do not have out-of-school maths support.

25. My parents expect me to do well in mathematics at school.

- ◯ Agree a lot
- ◯ Agree a little
- ◯ Disagree a little
- ◯ Disagree a lot

Section B: What are very important to you

Example

Question: When choosing a new mobile phone, what do you think are very important to you?

Responses:

Screen size. A big screen size is impt to me because I work on my phone a lot.

Weight. It is hard to walk around with a heavy phone in the pocket.

Connectivity. A USB slot would be my dream. Transfers file efficiently.

26. What do you think are very important when *learning mathematics*?
(Write up to three things which you think are very important)

.

.

.

27. Think about your *mathematics teacher* this year. What do you think are very important to him/her in mathematics teaching?

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Sometimes we come across situations when what is very important to you may not be regarded as very important by your mathematics teacher. Or, what is very important to your mathematics teacher may not be very important to you. Recall one such learning / teaching situation.
(Take your time to think of one)

28. What was the learning / teaching situation like?

29. What did you and/or your teacher do to try to resolve the situation?

30. Is the situation still present in class?

31. How has this situation affected your mathematics learning?

Thank you for your participation!

APPENDIX 2: JOURNAL ARTICLE WRITTEN BY OUR JAPANESE TEAM

Suggested citation:

Kinone, C., Soeda, Y., & Watanabe, K. (in print). The influences of teacher valuing on the development of student valuing in mathematics education: Data analysis of questionnaire survey in Miyazaki Prefecture using the questionnaire WIFItoo developed by international comparative study The Third Wave [in Japanese]. Research in Mathematics Education (Journal of Japan Academic Society of Mathematical Education), 26(1).

数学教育における生徒の価値観形成に及ぼす教師の影響に関する研究（1）

―国際比較調査「第三の波」質問紙 *WIFI too* を用いた宮崎県データ分析―

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1. はじめに

我が国では，子どもたちの生きる力の育成を一層重視する観点から，学力の三要素が学校教育法 30 条 2 項に示された。また，平成 29 年に告示された学習指導要領では，これからの知識基盤社会という時代に必要な資質･能力として，知識・技能，思考力・判断力・表現力等，学びに向かう力・人間性等の三つの柱が明記され，各教科の特質に応じた見方･考え方が重視されることとなった。こうした動向は，育成すべき資質･能力の捉え方が，知識･技能などの認知的側面に偏重したものから，情意的側面や他者との協働性なども含む，より包括的な捉え方へと移行したことを意味する（松尾，2016）。

その一方で，数学学習に関する我が国の生徒の実態は，例えば，TIMSS や PISA の結果からも分かるように，認知的側面では高い能力を有していながら，数学に対する興味･関心や有用感，自己肯定感や自信は低く，情意的側面において望ましい実態にあるとはいえない。こうした認知的側面と情意的側面の乖離は，日本の数学教育の課題として長年認識されてきたものの，いまだ十分に克服できていない（渡邊，2012）。

情意的側面に関する日本の数学教育研究では，数学学習に対する情動･信念･態度といった，学習者の情意の実態を分析する基礎的科学的研究，学習者に望ましい情意を獲得させるための学習指導やその評価に関する教育実践的研究，全国調査や国際調査の結果から学習者の情意の今後の在り方を考察する広域的調査研究がこれまで取り組まれてきた。しかし，情意的側面と認知的側面の関連づけや，そのための研究方法の確立という点は，今後の課題として指摘されてきた（今井，2010）。

一方，海外の数学教育研究では，認知･動機･情動，情意的状態と情意的特性，生理的･心理的･社会的様相といった次元を含む概念枠組み（Hannula, 2011）が提唱されるなど，数学学習に対する情意をより多角的に捉える試みがなされている。さらに，それまで個別に取り扱われてきた認知，動機，情動を統合的に取り扱い，それらの相乗的な関係に焦点を当てた研究の必要性が主張されてきた（Hannula，2012）。

近年の数学教育研究では，安定的な動機的特性の要素として「価値観」を捉え（Hannula，2012），人間の深層心理に位置づき，個人の意思決定や行動に影響を与え，認知的側面と情意的側面を架橋するものとして注目を集めるようになり，その代表的研究として，日本を含む 11 の国と地域が参加する国際比較調査「第三の波」（Seah *et al.*, 2012; Seah, 2013a; Seah *et al.*, 2017）がある。

この国際比較調査は，認知的側面，情意的側面に続く，第三の研究アプローチとして価値観に焦点を当て，それぞれの国や地域の数学教育において教師と生徒が共有する価値観やその形成過程（社会文化的文脈や教室での社会的相互作用など）を明らかにし，国際比較を通してその共通性や独自性を導出することを目指している。この調査では，これまで授業分析や質問紙調査を通して，各国･地域の数学教師や生徒が有する数学学習に対する価値観の実態が明らかにされてきた（Seah & Wong, 2012）。

日本に関しては，これまで 5 府県（秋田，埼玉，大阪，広島，宮崎）の小中学校の児童生徒を対象とした質問紙調査により，以下の点が明らかにされてきた。まず，日本の児童生徒の価値観を構成する因子として，数学学習における多様な考えと正しい理解，数学の本質，数学学習の見える成果，数学学習における他者の関与，問題を解く手がかり，数学学習における ICT･電卓の使用が導出された（木根他，2013；Shinno *et.al.*，2014；二宮他，2015）。また，校種間の比較を通して，小学生は問題の自力解決，数学学習における操作や活動，数学に関する神秘や論理性に，中学生は問題解決の結果に，それぞれ価値を見出す傾向が導出された。さらに，都鄙間の比較を通して，都市部の児童生徒の方が，数学学習における活動や習熟に価値を見出す傾向が導出された（馬場，2013；木根，2013，真野；2013）。そして，全国学力・学習状況調査で高い成績をおさめる秋田の小学生の特徴

として，他の府県に比べて，数学学習における他者の関与に価値を見出す傾向が導出され，全県的に取り組まれている学び合いを重視した授業がその要因と推察された（二宮他，2015）。

こうした成果は，限定的ではあるものの，日本の数学教育が重視してきた数学的な考え方が児童生徒の価値観へ浸透している実態や，対話的な学びを重視する価値観と学力との関連性を示唆するものといえる。しかしながら，価値観の形成過程までは十分解明できておらず，認知的側面と情意的側面の乖離解消にむけて，その解明は喫緊の課題である。

2017 年から開始された第三の波の調査では，各国・地域の数学教師が質の高い学習にむけて多様な価値観を授業でどのように取り扱っているかを明らかにすることが目指されている。そのために，教師と生徒の価値観比較にむけた質問紙“*What I Find Important (in mathematics learning) too*”（*WIFI too*）が開発され，質問紙調査，授業分析，インタビュー調査の実施と，収集データの国際比較分析が行われる。

本研究は，この第三の波に依拠し，日本の数学教育における生徒の価値観の形成過程と，それに及ぼす数学教師の価値観の影響を明らかにすることを目的とする。この目的を達成するために，北海道，秋田，埼玉，東京，大阪，広島，宮崎の 7 都道府県を研究対象地域とし，以下の課題に取り組む。

① 数学教師と彼らが担当する生徒を対象とした質問紙調査を実施し，生徒と教師の価値観の関係の特徴を明らかにする。
② 個別の数学授業に対する授業ビデオ分析やインタビュー調査を実施し，生徒の価値観の形成過程や，それに及ぼす教師の影響を明らかにする。
③ 国際比較分析を通して，日本の数学教育における生徒の価値観の形成過程や，それに対する教師の影響の特徴を明らかにする。

本稿では，課題①の宮崎県データに関する分析結果を報告する。はじめに，第三の波で構築された数学教育における価値観の概念枠組みと，教師と生徒の価値観比較にむけて開発された質問紙 *WIFI too* を概観する。そして，*WIFItoo* を用いた質問紙調査で収集した宮崎県データの一部を分析し，生徒と教師の価値観の関係の特徴を考察する。

2. 数学教育における価値観の概念枠組み

第三の波では，数学教育における価値観を，「学校数学の学習や教授を行うにあたり，ある個人が重要だとみなす個人的な確信」と定義し（Seah & Peng, 2012, p.73），その構成要素として，数学的価値観，文化的・一般教育的価値観，数学教育的価値観の 3 次元が設定されている。

Seah(2013b)によれば，数学的価値観は「西洋数学の伝統において強調されてきた確信」（p.194）であり，その下位次元として，Bishop(1988)の「数学文化の諸価値」を踏まえ，世界観・信念としての合理主義と物化主義，感情・態度としての支配感と進歩感，人間関係・制度としての開放性と神秘性という，3 つの相補的な価値の組が位置づけられている。

また，文化的・一般教育的価値観は，「教育制度が生徒に教え込もうとするもの」であり，それぞれの学校，国家，文化圏における価値観に相当するものとして捉えられている（Seah, 2013b, p.194）。この文化的・一般教育的価値観の下位次元としては，権力格差，個人主義と集団主義，男らしさと女らしさ（自立性と依存性），不確実性の回避，長期の方針と短期の方針，包括性（思考の柔軟性）が位置づけられている。

そして，数学教育的価値観は，「数学教育を正式に

表 1：数学教育的価値観の下位次元

	下位次元	内容
1	才能	学習者の才能を重視する。
	努力	学習者の努力を重視する。
2	心地よさ	落ち着いて，楽しく学習ができる，心地よい学習環境や雰囲気を重視する。
	厳しさ	緊張感があり，懸命さが求められる，厳しい学習環境や雰囲気を重視する。
3	過程	学習の過程を重視する。
	結果	学習の結果を重視する。
4	活用	様々な問題場面に対する数学の活用を重視する。
	計算・処理	数学の計算・処理を重視する。
5	数学世界における事実	数学の世界における事実を重視する。
	現実世界での使用	現実世界での数学の使用を重視する。
6	他者の解説	教師や友人といった，他者が数学を教えてくれることを重視する。
	自らの探究	友人との協働を含め，学習者自身による数学の学習を重視する。
7	想起	他者から与えられた知識を正しく思い出すことを重視する。
	創造	学習者自身が数学を創造していくことを重視する。

（木根＆Seah，2015，p.100 より筆者修正）

実施する教育機関における規範に関係する価値観」（Bishop, 1998, p.34; Seah & Bishop, 2002），「学校の教室において数学を教えるという状況から生じる価値観」（Clarkson *et al.*, 2000, p.188），「学校数学の教授実践を通して表現されるもの」（Seah, 2013b, p.194）などのように，学校教育における数学の授業（学習・教授）特有の価値観として捉えられている。

数学教育的価値観の下位次元としては，第三の波の研究成果を踏まえ，「才能」と「努力」，「心地よさ」と「厳しさ」，「過程」と「結果」，「活用」と「計算・処理」，「数学世界における事実」と「現実世界での使用」，「他者の解説」と「自らの探究」，「想起」と「創造」という，7 つの相補的な価値観の組が位置づけられている。筆者等は，これらの下位次元について，第三の波関連の文献を検討し，表 1 のような整理を行った（木根&Seah，2015）。

3. 質問紙 *WIFI too* の概要

この調査で用いる質問紙 *WIFI too* は，教師用と生徒用の質問紙が別々に開発されており，それぞれの回答の比較を通して，教師と生徒の価値観の類似点や相違点，さらには，両者の価値観の関係を明らかにする。

教師用質問紙は 36 の質問項目で構成されている。まず，項目 1～17 は，勤務校や教授言語，出身地域や性別，年齢，教職年数や教師教育経験など，回答者の個人情報に関するものである。次に，項目 18～21 は，数学の学習や教授において重要と思うことを自由記述で 3 つずつ回答するものであり，具体的には表 2 のとおりである。そして，項目 22～34 は，これまで実施してきた数学授業において，教師と生徒が重要と思うことに乖離が生じた状況を問うものであり，項目 35～36 は回答者の連絡先を記述するものである。

一方，生徒用質問紙は 32 の質問項目で構成されている。まず，項目 1~14 は，在籍する学校や教授言語，家庭環境や年齢，性別など，回答者の個人情報に関するものである。次に，項目 15～25 は，数学学習の有用性や必要性，数学学習において重要と思うことなどに関する選択式（4 件法）の質問である。項目 26～28 は，数学の学習や教授において，自分自身や自分の教師が重要と思うことを自由記述で 3 つずつ回答するものであり，具体的には表 3 のとおりである。そして，項目 29～32 は，これまで受けてきた数学授業において，教師と生徒が重要と思うことに乖離が生じた状況を問うものである。

質問紙 *WIFI too* は英語で作成されており，日本における調査にむけて，次の翻訳作業を行った。まず，3 名の日本人研究者がそれぞれで日本語に翻訳した。その結果を比較検討し，第一段階の日本語訳を作成した。次に，日本語への翻訳担当者とは別の日本人研究者が，第一段階の日本語訳を英語に翻訳し，その英訳と原文を，第三の波の研究代表者である Seah 氏が比較検討した。その結果，日本語訳が原文の意味を十分に反映していることを確認した。

本稿では，教師と生徒のそれぞれが数学授業において重要と思うことを回答する質問項目に注目する。具体的には，教師用項目 18・19・20・21 と，生徒用項目 26・27・28 である。

4. 研究の方法

(1) 調査の対象

WIFItoo を用いた質問紙調査では，各国･地域の優れた授業実践を行う数学教師が，数学授業を通して，生徒の価値観形成にどのような影響を及ぼすのかを明らかにすることが目指される。

そこで，優れた授業実践を行う中学校数学教師の選定基準として，教職経験が 10 年以上，授業実践に熱心な数学教師，派遣研修生や教職大学院生として，半年から 1 年の間，現場を離れ，大学で研究活動に取り組んだ経験を有することを設定し，宮崎県の教育行政区（北部･中部･南部）から 1 名ずつ選定した。3 名（教師 A・B・C）の教師とそれぞれの担当する学級の生徒の内訳は，表 4 のとおりである。

表 2:教師用 *WIFItoo* 質問項目

項目	内容
18	**誰か**が数学を**学習**するとき，その人の学習の助けとなる重要なことは何だと思いますか。
19	**誰か**が数学を**教える**とき，その人の教授の助けとなる重要なことは何だと思いますか。
20	**自分**が数学を**学習**するとき，自分の学習の助けとなる重要なことは何ですか。
21	**自分**が数学を**教える**とき，良い教授の助けとなる重要なことは何ですか。

表 3:生徒用 *WIFItoo* 質問項目

項目	内容
26	**誰か**が数学を**学習**するとき，その人の学習の助けとなる重要なことは何だと思いますか。
27	**自分**が数学を**学習**するとき，自分の学習の助けとなる重要なことは何ですか。
28	今年の**あなたの数学**の先生について考えてください。あなたは，その先生が数学を**教えるときに重要**だと思っていることは何だと思いますか。

表 4:研究対象の内訳

教師	性別	年齢	教職歴	学級	生徒数	合計
A	女	44	22	2 年 (1 学級)	34	34
B	男	41	18	1 年 (1 学級)	28	130
				2 年 (3 学級)	102	
C	男	39	15	1 年 (2 学級)	46	106
				3 年 (2 学級)	60	

(2) データ収集の方法

質問紙調査の実施方法としては，まず，選定された数学教師に調査の主旨や調査内容について説明した。その説明を受けて，選定された教師は，それぞれの都合に合わせて，数学の授業を担当する学級で質問紙を配付し，生徒に回答するよう指示し，回答後，質問用紙を回収した。生徒が質問紙に記入する際には，極力，教師からの説明を控えるよう依頼した。

質問紙調査の依頼は，2018 年 3 月上旬に行い，質問紙の回収は 3 月下旬に行った。

(3) データ分析の方法

質的データ分析支援ソフトウェア NVivo 12 を用いて，教師と生徒の質問紙への回答を，それぞれ以下の手順で分析した。

まず，教師の回答の分析は，教師用項目 18～21 に対する回答記述を，表 1 に示した数学教育的価値観の下位次元に分類した。記述が短いものもあったが，項目 18～21 も含めた，教師用質問紙全体の回答内容を踏まえたうえで，下位次元への分類を行った。

次に，生徒の回答の分析については，はじめに回答記述を要約するかたちでオープンコーディング（佐藤，2008，p.97）を行った。記述に用いられた象徴的な言葉，回答者が述べようとしている内容や意図，背景などを考慮しながら，各記述内容を一言で表す言葉をオープンコードとして割り当てた。

例えば，「数学の公式」や「計算方法」という記述には，公式や方法といった手続き的知識が重視されていると判断し，「手順･やり方･解き方・公式」というコードを割り当てた。また，「公式を覚える」という記述には，公式を重視していることに加え，その公式の学び方として覚えることが重視されていると判断し，「手順･やり方･解き方・公式」と「公式を覚える」の 2 つのコードを割り当てた。さらに，教師や友人など他者との関係について述べた記述が数多く見られたが，そのなかには，良好な人間関係に焦点化されたものや，他者が自分の分からないことを分かるように教えてくれることを重視したもの，ともに問題解決に取り組む他者との協働を重視するものがあり，そうした記述を区別するために，「人間関係」，「解説の質」，「集団の探究」というコードを割り当てた。

次に，オープンコードを数学教育的価値観の下位次元に分類し，それぞれの下位次元において，もとの回答記述を比較し，オープンコーディングや下位次元の分類の妥当性を検討し，オープンコーディングや下位次元への分類の修正を行った。

例えば，快適に学習するために必要な教科書や筆記用具が重要だと述べている記述に割り当てた「快適な環境」，分からない内容を教えてくれる教師や一緒に学習してくれる友人との良好な人間関係を重視した記述に割り当てた「人間関係」，そして，落ち着いて学習に取り組むために休息やおやつなどが取れることが大事だと述べている記述に割り当てた「休憩･休息」，「食事･おやつ」というオープンコードは，どれも落ち着いて，楽しく学習ができる，心地よい学習環境や雰囲気を重視したものと見なし，下位次元「心地よさ」に割り当てた。

その結果，数学教育的価値観の下位次元とオープンコードの対応は，表 5 のようになった。

5. 分析の結果

各教師とその生徒の記述に関する分析結果を行う。教師の回答については，教師用項目 18～21 の回答記述を示し，その特徴を述べる。生徒の回答については，生徒用項目 26～28 の回答記述に対するコーディング結果を，数学教育的価値観の下位次元ごとに集計し，各教師の生徒数に対する下位次元に該当する生徒数の割合を教師ごとに算出し，その特徴を述べる。

(1) 教師 A とその生徒の回答について

① 教師 A の回答

A の教師用項目 18～21 に対する回答は，表 6 のとおりである。

A の回答の特徴として，まず，基礎･基本や知識，定義，公式に関する記述が多いことから，「結果」を重視する傾向がみられる。次に，柔軟な考え方や，授業者としての教材理解につながる教材研究が記述されていることから，「過程」を重視する傾向がみられる。また，生徒に分かりやすく伝えるための授業者としての力や引き出しに関する記述があることから，「他者からの解説」も重視する傾向があることが分

表 5:数学教育的価値観の下位次元とオープンコードの対応

	下位次元	オープンコード	具体的な記述例
1	才能	頭脳，勘，感覚，才能，頭のよさ	「知能力。考える知能などが無ければ，計算などが出来ないからです。」「頭脳」「かん」「感かく」「さいのう」
	努力	意欲・主体性・根気，練習・問題，復習，集中・集中力，ノート記述，予習，努力，スモールステップ，丁寧さ・見直し，態度，塾に行く，持続，自信，達成感，冷静さ	「わからないと思うことがあって，そのままにするともっとできなくなるので，わからなくてもといてみる。」「やる気。やる気をつけないと始まらないから」「集中。集中しないと，勉強が進まないから。」
2	心地よさ	快適な環境（教科書･参考書･問題集･プリント，文房具，環境・設備，電卓･パソコン・タブレット，雰囲気，インターネット，音楽・BGM），人間関係（教えてくれる人，一緒に学習する仲間・友達，励まし・寄り添い，相手意識，認め合う・発言しやすさ，コミュニケーション），時間，休憩・休息，やりやすさ・便利さ，報酬，食事・おやつ	「教科書。教科書を見ながら勉強したら分かるから。」「所持品。人は自分にとって使いやすい筆記用具を使用すると，意欲がわくきっかけとなるから。」「周りのきずかい。わからないところをおしえてあげないと分からないままだから。」「友達。分からないときに助けてくれるから。」「分からない所をききやすくする環境を作る」「相手の立場に立って上から目線では絶対教えない。」「食べ物(音楽も)。好きなものを食べながらすると，私は集中できるから。」
	厳しさ	厳しさ・学習規律，授業のペース，入試・テストの意識，強いられる・強制，切磋琢磨・競争，型にはめる，難しい問題，能力向上・鍛錬	「何回も同じことをいわれないようにいいかげんわかる」「話をきくこと。わからなくても話をきくのが大切だと思っているから。」「何か大事な発言をするとき，皆の顔があがっていて，聞けているか。」「友達との力くらべ，をすることで，せっさたくまできること」
3	過程	理解・分かる，考え方・考え，過程，理由，知恵・ポイント	「理解力。まずは理解することが大切だと思うから。」「なぜその答えになるのかの説明」
	結果	手順・やり方・解き方・公式，基礎・基本，知識（用語･語句），正解	「公式を覚えていつでも使えるように頭の中に引き出しをつくっておく」「分からないときは，答えを見て何度もとく」
4	活用	応用問題，応用力，活用	「応用問題を出したりする。基本だけではなく，応用の練習もする。」「応用力。難しい問題でもとけるようにする。」
	計算・処理	計算・計算力，速さ，正確さ，簡潔・簡単，問題を解ける	「計算力。計算を早くできること，問題を早く解ける。」「できるだけ簡単に解く(式)」
5	数学世界における事実	規則性	「規則性，規則性が分かればその先のことが分かったりするから。」
	現実世界での使用	日常生活での使用，身近な事例，数学の必要性，問題文のなかの数学	「今後の日常生活など仕事などに使用する場合のこと。」「応用…普段の生活で役に立てることができると思うから。」
6	他者の解説	解説の質（分かりやすさ，分かるまで教える，教え方，個に応じた教え方，聞きやすさ・声の大きさ，丁寧，平等に教える，熱心さ，正しさ･正確さ，板書の字の見やすさ，表情），解説の方法（説明する，図・表を用いる，身近なものでの例える，ジェスチャー，板書する，ICT を用いる），解説の内容（ヒント・助言をする，手続きを教える，要点を教える，分からないところを教える，答えを教える，知識を教える，多様な解き方を教える，基本を教える，既習事項の確認）	「分からない人に個別で教えてくれる。」「ゆっくりていねいに教えてくれている。」「わかりやすく。私達に合わせて簡潔に分かりやすく教えること。」「分かるまで教える。分からないままにしておくと分からないままになってしまうから」「アドバイス。わからないところを教える」「分かる人がポイントを教え，何問かいっしょに解く」「わかる人がわからない人に説明をする。」「友達が教えること。分からないことをそのままにせずに友達が教えてあげる。」「おしえてもらう。分からなかったら分かる人に教えてもらって分かるようにする」「わからない場所は，図などを使いくわしくおしえる。」「例。難しい問題を解くとき，頭ではなく，物などを使って教えると分かりやすいから。」「タブレットとかでせつめいする。」
	自らの探究	個人の探究（自分で考える・解く･取り組む，好奇心・数学のおもしろさ，教科書・資料を読む，表現・発表する，多様な考え方をする，道具を使う，ICT を用いる，実験・体験），集団の探究（教え合い・助け合い，話し合い，一緒に考える，協力，考えの比較）	「自分の考えを持って取り組む」「色々な視点で考えてみること」「自力。解けない問題が出た時には，知恵をしぼって，どうにか解かないとすっきりしないから。」「生徒が自分たちで答えを見つけ出すこと。」「分からないことを教え合ったり，きいたりすること。」「協力。人と話して分からないところは，話し合う。」「意見を共有する。いろんな意見を持っておけば，その意見を活用できるから。」
7	想起	公式を覚える，覚える，基礎･基本を覚える，用語・語句を覚える，手続きを覚える	「公式を覚えること」「計算の仕方などをきちんとおぼえてもらう。」「証明とかをはやく覚える」
	創造	（なし）	（該当する記述なし）

表 6:教師 A の記述

	誰かにとって	自分にとって
数学学習	項目 18： • 公式や定義などを含めた基礎基本の定着 • 数多くの引き出し（豊富な知識） • 計算力	項目 20： • 基礎基本 • 豊富な知識 • 柔軟な考え方
数学教授	項目 19： • 豊富な知識 • 柔軟な考え方 • 生徒に分かりやすく伝える力	項目 21： • 教材研究（他の教師との協議） • 豊富な知識 • 生徒理解

かる。あと，基礎基本の定着の記述から「努力」，生徒とのよりよい人間関係の構築を目指した生徒理解という記述から「心地よさ」，計算力から「計算・処理」，そして，教材研究や他の教師との協議から「自らの探究」を重視する傾向もみられる。

以上のことから，A の価値観を構成する要素として，「結果」，「過程」，「他者からの解説」，「努力」，「心地よさ」，「計算・処理」，「自らの探究」を同定することができる。

② 教師 A の生徒の回答

生徒用項目 26～28 の回答記述に対するコーディングの集計結果は，表 7 のとおりである。

表 7:教師 A の生徒の回答（2 年 34 名）

	下位次元	項目 26		項目 27		項目 28	
		人	%	人	%	人	%
1	才能	0	0.0	0	0.0	0	0.0
	努力	6	17.6	11	32.4	15	44.1
2	心地よさ	8	23.5	8	23.5	6	17.6
	厳しさ	0	0.0	0	0.0	3	8.8
3	過程	4	11.8	1	2.9	2	5.9
	結果	10	29.4	7	20.6	12	35.3
4	活用	0	0.0	0	0.0	0	0.0
	計算・処理	5	14.7	5	14.7	2	5.9
5	数学世界における事実	0	0.0	0	0.0	0	0.0
	現実世界での使用	0	0.0	1	2.9	0	0.0
6	他者の解説	17	50.0	14	41.2	15	44.1
	自らの探究	12	35.3	17	50.0	7	20.6
7	想起	6	17.6	6	17.6	8	23.5
	創造	0	0.0	0	0.0	0	0.0

まず，項目 26 の集計結果から，回答率の高い下位次元は「他者の解説」（50.0%），「自らの探究」（35.3%），「結果」（29.4%）であり，これらを A の生徒が一般論として重視していることが分かる。一方，回答率の低い下位次元は「才能」（0.0%），「厳しさ」（0.0%），「活用」（0.0%），「数学世界における事実」（0.0%），「現実世界での使用」（0.0%），「創造」（0.0%）であり，これらを A の生徒が一般論として重視しているとはいえない。

次に，項目 27 の集計結果から，回答率の高い下位次元は「自らの探究」（50.0%），「他者の解説」（41.2%），「努力」（32.4%）であり，これらを生徒自身が重視していることが分かる。一方，回答率の低い下位次元は「才能」（0.0%），「厳しさ」（0.0%），「過程」（2.9%），「活用」（0.0%），「数学世界における事実」（0.0%），「現実世界での使用」（2.9%），「創造」（0.0%）であり，これらを生徒自身が重視しているとはいえない。

そして，項目 28 の集計結果から，回答率の高い下位次元は「努力」（44.1%），「他者の解説」（44.1%），「結果」（35.3%）であり，これらを A は重視していると生徒が捉えていることが分かる。一方，回答率の低い下位次元は「才能」（0.0%），「活用」（0.0%），「数学世界における事実」（0.0%），「現実世界での使用」（0.0%），「創造」（0.0%）であり，これらを A は重視していると生徒が捉えているとはいえない。

⑵ 教師 B とその生徒の回答について

① 教師 B の回答

B の教師用項目 18～21 に対する回答は，表 8 のとおりである。

表 8:教師 B の価値観に関する記述

	誰かにとって	自分にとって
数学学習	項目 18： • それまでの学習で学んだ知識。既知，既習内容をいかす。 • 教科書。学んだこと，学んでいくことがかいてあり，予習・復習ができる。 • 気持ち。分かろう，理解しようとする気持ち。	項目 20： • 教科書。予習・復習がしやすい。 • 参考書。解き方のアドバイスなどがのっている。 • Youtube などの動画。
数学教授	項目 19： • 教科書。教えるべき内容の基本となり，内容にミスがないから。 • Youtube などの動画。教え方が分からないときに参考になる。 • 分からないところを周りの先生方にきく。	項目 21： • 教科書。子ども達が学ぶときのもとになるから。 • 学習指導要領。教えるべき内容やつながりが詳しくのってある。 • 先輩などまわりの先生。

B の回答の特徴として，教科書や学習指導要領，インターネットといった教授・学習に関する情報収集のための快適な環境や，相談できる同僚の存在に関する記述が多いことから，「心地よさ」を重視する

傾向がみられる。次に，学習内容を理解しようとする気持ちや予習・復習に関する記述が多いことから，「努力」を重視する傾向がみられる。また，解き方や既習事項といった「結果」に関する記述や，教え方や疑問点について説明を求めるといった「他者の解説」に関する記述，学習内容を理解するといった「過程」に関する記述，既習事項を活かすといった「活用」に関する記述も見られる。

以上のことから，B の価値観を構成する要素として，数学学習に関する情報を得る環境面や，頼りになる人間関係の充実といった「心地よさ」をはじめ，「努力」，「結果」，「他者の解説」，「過程」，「活用」を同定することができた。

② 教師 B の生徒の回答

生徒用項目 26～28 の回答記述に対するコーディングの集計結果は，表 9 のとおりである。

まず，項目 26 の集計結果から，回答率の高い下位次元は「心地よさ」(74.6%)，「努力」(49.2%)，「他者の解説」(33.8%) であり，これらを B の生徒が一般論として重視していることが分かる。一方，回答率の低い下位次元は「才能」(2.3%)，「厳しさ」(3.8%)，「活用」(0.0%)，「計算・処理」(4.6%)，「数学世界における事実」(0.8%)，「現実世界での使用」(0.8%)，「創造」(0.0%) であり，これらを B の生徒が一般論として重視しているとはいえない。学年間を比較して，1 年から 2 年へ回答率が高くなったものは「努力」(17.2%増) と「心地よさ」(13.2%増) で，低くなったものは「他者の解説」(11.5%減) と「自らの探究」(18.4%減) である。

次に，項目 27 の集計結果から，回答率の高い下位次元は「心地よさ」(73.1%)，「努力」(52.3%)，「他者の解説」(30.0%) であり，これらを生徒自身が重視していることが分かる。一方，回答率の低い下位次元は「才能」(1.5%)，「厳しさ」(1.5%)，「活用」(0.8%)，「数学世界における事実」(0.0%)，「現実世界での使用」(0.0%)，「創造」(0.0%) であり，これらを生徒自身が重視しているとはいえない。1 年から 2 年へ回答率が低くなったものは「想起」(13.0%減) である。

そして，項目 28 の集計結果から，回答率の高い下位次元は「他者の解説」(50.8%)，「努力」(35.4%)，「厳しさ」(35.4%)，「自らの探究」(28.5%) であり，これらを B は重視していると生徒が捉えていることが分かる。一方，回答率の低い下位次元は「才能」(0.0%)，「活用」(0.0%)，「数学世界における事実」(0.0%)，「現実世界での使用」(0.8%)，「創造」(0.0%) であり，これらを B は重視していると生徒が捉えているとはいえない。1 年から 2 年へ回答率が高くなったものは「努力」(31.4%増) と「計算・処理」(23.5%増) で，低くなったものは「心地よさ」(23.0%減) と「他者の解説」(17.2%増) である。

(3) 教師 C とその生徒の回答について

① 教師 C の回答

C の教師用項目 18～21 に対する回答は，表 10 のとおりである。

C の回答の特徴として，まずは，教授・学習に関する情報収集に必要な参考書や，相談できる同僚の存在に関する記述がかなり多いことから，「心地よさ」を重視する傾向がみられる。次に，指導法や他者の説

表 9:教師 B の生徒の回答(1 年 28 名，2 年 102 名)

	下位次元	項目 26						項目 27						項目 28					
		1 年		2 年		全体		1 年		2 年		全体		1 年		2 年		全体	
		人	%	人	%	人	%	人	%	人	%	人	%	人	%	人	%	人	%
1	才能	0	0.0	3	2.9	3	2.3	0	0.0	2	2.0	2	1.5	0	0.0	0	0.0	0	0.0
	努力	10	35.7	54	52.9	64	49.2	13	46.4	55	53.9	68	52.3	3	10.7	43	42.2	46	35.4
2	心地よさ	18	64.3	79	77.5	97	74.6	19	67.9	76	74.5	95	73.1	10	35.7	13	12.7	23	17.7
	厳しさ	0	0.0	5	4.9	5	3.8	1	3.6	1	1.0	2	1.5	8	28.6	38	37.3	46	35.4
3	過程	3	10.7	14	13.7	17	13.1	3	10.7	11	10.8	14	10.8	6	21.4	19	18.6	25	19.2
	結果	7	25.0	17	16.7	24	18.5	4	14.3	12	11.8	16	12.3	4	14.3	12	11.8	16	12.3
4	活用	0	0.0	0	0.0	0	0.0	1	3.6	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
	計算・処理	0	0.0	6	5.9	6	4.6	0	0.0	8	7.8	8	6.2	0	0.0	24	23.5	24	18.5
5	数学世界における事実	1	3.6	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	現実世界での使用	1	3.6	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	1	3.6	0	0.0	1	0.8
6	他者の解説	12	42.9	32	31.4	44	33.8	9	32.1	30	29.4	39	30.0	18	64.3	48	47.1	66	50.8
	自らの探究	9	32.1	14	13.7	23	17.7	4	14.3	21	20.6	25	19.2	7	25.0	30	29.4	37	28.5
7	想起	3	10.7	6	5.9	9	6.9	5	17.9	5	4.9	10	7.7	4	14.3	7	6.9	11	8.5
	創造	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

表 10:教師 C の価値観に関する記述

	誰かにとって	自分にとって
数学学習	項目 18： • 仲間。分からない問題を教え合うため。 • 聴く力。理解するために聴くことが大事。 • 先生。教える力が大切。	項目 20： • 仲間。教え合う仲間。 • 参考書。解説が必要。 • （なし）
数学教授	項目 19： • 同僚。指導法の共有。 • 参考書。数学の単元内容を教える目的。 • （なし）	項目 21： • 同僚。指導法の共有。 • 参考書および参考となる指導法。 • （なし）

明を聴く力に関する記述が多いことから，「他者の解説」を重視する傾向がみられる。そして，分からない問題を教え合う記述から，「自らの探究」を重視する傾向もみられた。

以上のことから，C の価値観を構成する要素として，数学学習に関する情報を得る文献や人間関係の充実といった「心地よさ」をはじめ，「他者の解説」や「自らの探究」を同定することができる。

② 教師 C の生徒の回答

生徒用項目 26～28 の回答記述に対するコーディングの集計結果は，表 11 のとおりである。

まず，項目 26 の集計結果から，回答率の高い下位次元は「他者の解説」（40.6%），「自らの探究」（29.2%），「心地よさ」（28.3%）であり，これらを C の生徒が一般論として重視していることが分かる。一方，回答率の低い下位次元は「才能」（0.0%），「厳しさ」（0.9%），「活用」（0.9%），「数学世界における事実」（0.0%），「現実世界での使用」（0.9%），「創造」（0.0%）であり，これらを C の生徒が一般論として重視しているとはいえない。学年間を比較して，1 年から 3 年へ回答率が低くなったものは「他者の解説」（16.7%減）である。

次に，項目 27 の集計結果から，回答率の高い下位次元は「心地よさ」（42.5%），「努力」（39.6%），「他者の解説」（31.1%）であり，これらを生徒自身が重視していることが分かる。一方，回答率の低い下位次元は「才能」（1.9%），「厳しさ」（0.0%），「活用」（0.0%），「計算・処理」（4.7%），「数学世界における事実」（0.0%），「現実世界での使用」（1.9%），「想起」（2.8%），「創造」（0.0%）であり，これらを生徒自身が重視しているとはいえない。1 年から 3 年へ回答率が低くなったものは「努力」（14.5%減），「結果」（11.7%減），「他者の解説」（10.3%減）である。

そして，項目 28 の集計結果から，回答率の高い下位次元は「他者の解説」（49.1%），「努力」（36.8%），「自らの探究」（24.5%）であり，これらを C は重視していると生徒が捉えていることが分かる。一方，回答率の低い下位次元は「才能」（0.0%），「厳しさ」（3.8%），「活用」（0.9%），「計算・処理」（0.9%），「数学世界における事実」（0.0%），「現実世界での使用」（1.9%），「創造」（0.0%）であり，これらを C は重視していると生徒が捉えているとはいえない。ちなみに，1 年から 3 年へ回答率が低くなったものは「他者の解説」（17.0%減）である。

6. 考察

生徒の価値観形成に対して教師の価値観が及ぼす影響を考察するにあたり，はじめに，教師が重視する

表 11:教師 C の生徒の回答（1 年 46 名，3 年 60 名）

	下位次元	項目 26						項目 27						項目 28					
		1 年		3 年		全体		1 年		3 年		全体		1 年		3 年		全体	
		人	%	人	%	人	%	人	%	人	%	人	%	人	%	人	%	人	%
1	才能	0	0.0	0	0.0	0	0.0	1	2.2	1	1.7	2	1.9	0	0.0	0	0.0	0	0.0
	努力	12	26.1	13	21.7	25	23.6	22	47.8	20	33.3	42	39.6	16	34.8	23	38.3	39	36.8
2	心地よさ	12	26.1	18	30.0	30	28.3	17	37.0	28	46.7	45	42.5	3	6.5	4	6.7	7	6.6
	厳しさ	0	0.0	1	1.7	1	0.9	0	0.0	0	0.0	0	0.0	3	6.5	1	1.7	4	3.8
3	過程	8	17.4	6	10.0	14	13.2	6	13.0	7	11.7	13	12.3	8	17.4	8	13.3	16	15.1
	結果	11	23.9	14	23.3	25	23.6	10	21.7	6	10.0	16	15.1	4	8.7	9	15.0	13	12.3
4	活用	0	0.0	1	1.7	1	0.9	0	0.0	0	0.0	0	0.0	1	2.2	0	0.0	1	0.9
	計算・処理	2	4.3	8	13.3	10	9.4	2	4.3	3	5.0	5	4.7	0	0.0	1	1.7	1	0.9
5	数学世界における事実	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	現実世界での使用	1	2.2	0	0.0	1	0.9	2	4.3	0	0.0	2	1.9	1	2.2	1	1.7	2	1.9
6	他者の解説	23	50.0	20	33.3	43	40.6	17	37.0	16	26.7	33	31.1	27	58.7	25	41.7	52	49.1
	自らの探究	16	34.8	15	25.0	31	29.2	10	21.7	8	13.3	18	17.0	10	21.7	16	26.7	26	24.5
7	想起	2	4.3	4	6.7	6	5.7	1	2.2	2	3.3	3	2.8	2	4.3	5	8.3	7	6.6
	創造	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

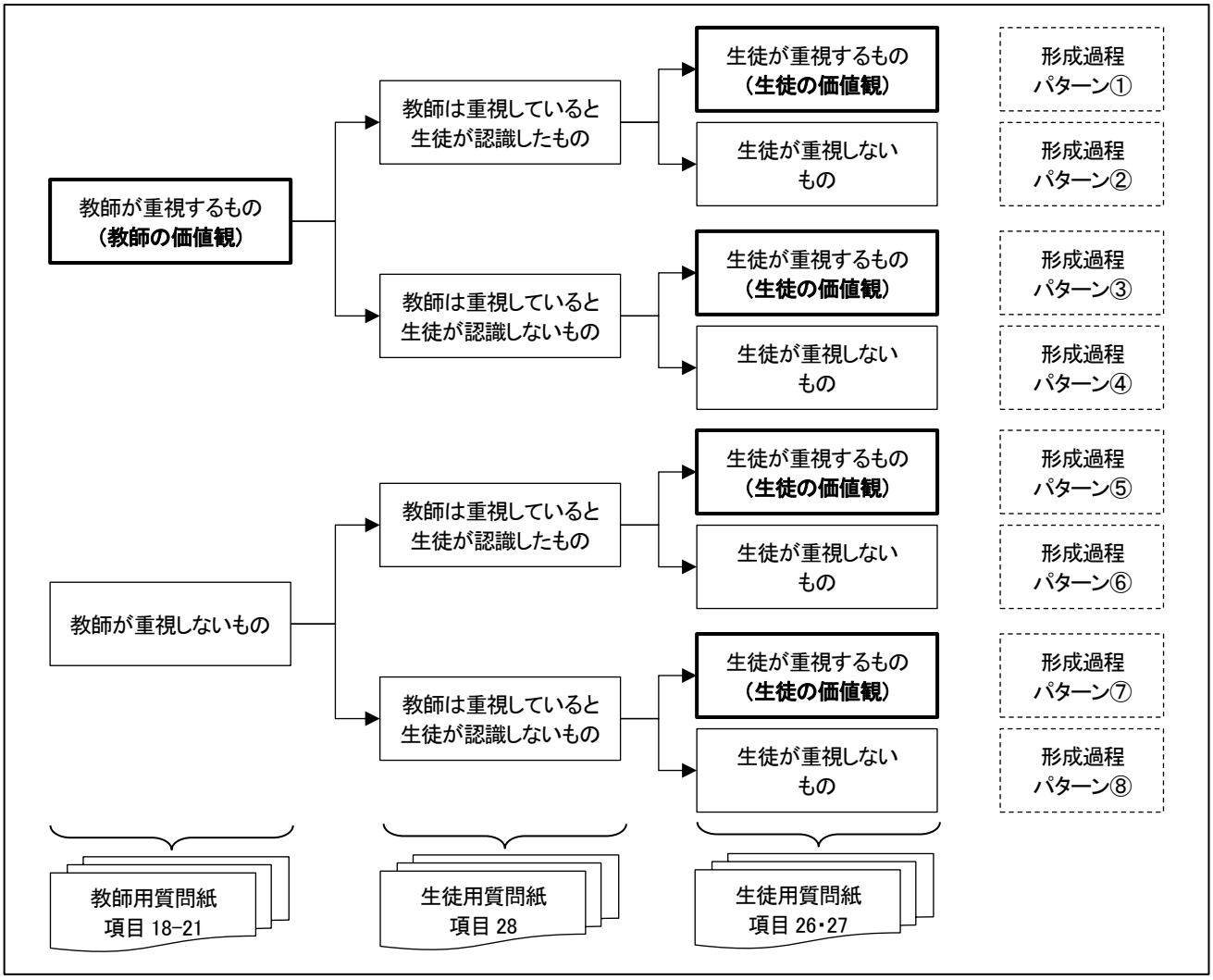

図 1:数学授業における生徒の価値観の形成過程モデル（暫定）

もの, 教師が重視するものに関する生徒の認識, そして，生徒が重視するものとのつながりを生徒の価値観の形成過程として捉えた「数学授業における生徒の価値観の形成過程モデル」（図 1）を設定する。

以下の考察では，教師が重視するものについては，教師用項目 18～21 に対する記述の特徴で判断する。教師が重視するものに関する生徒の認識を生徒用項目 28 の回答率で, 生徒が重視するものを生徒用項目 26・27 の回答率で，それぞれ判断する。そして，数学教育的価値観の下位次元のそれぞれが 8 つの形成過程パターンのどれに位置づくかに着目しながら考察を行う。B と C の生徒には複数の学年が含まれており，学年間の回答率の違いが約 30%のものが 1 つ（B の生徒用項目 28「努力」), 20%のものが 2 つ (B の生徒用項目 28「心地よさ」,「計算･処理」）確認された。しかし, 全体的にはそれほど大きな違いはないものと判断し, 複数学年が含まれる B と C の生徒は，それぞれひとつの集団として考察する。

(1) 教師 A とその生徒の価値観の関係

まず，質問紙の記述から読み取ることのできた A の価値観として,「努力」,「心地よさ」,「過程」,「結果」,「計算・処理」,「他者の解説」,「自らの探究」が挙げられる。一方,「才能」,「厳しさ」,「活用」,「数学世界における事実」,「現実世界での使用」,「想起」,「創造」は，A が重視するものとして回答記述からは読み取れなかった。そこで，A が重視するものとそうでないもの別に，A の生徒の回答率を，A が重視するものに関する生徒の認識 (項目 28), 一般論として重視するもの (項目 26), 生徒自身が重視するもの（項目 27）の順に図 2 のように整理した。

まず，A が重視する下位次元に注目すると，生徒用項目 27 に対する回答率の高い下位次元として「自らの探究」,「他者の解説」,「努力」が，また，回答率の低い下位次元として「過程」が含まれている。項目

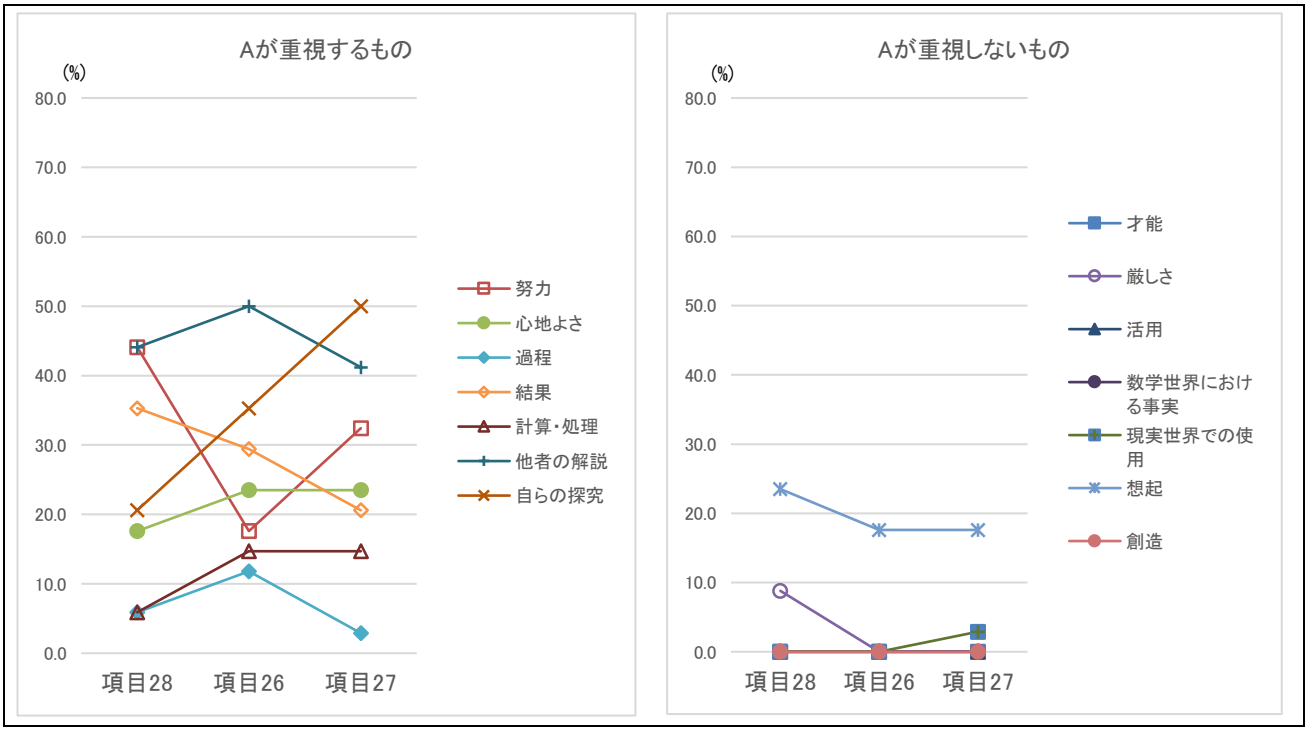

図 2:教師 A の生徒の価値観の形成過程

27 の回答率の高い下位次元のうち,「他者の解説」と「努力」は, 項目 28 に対する回答率も比較的高い(ともに 44.1%)が,「自らの探究」は項目 28 の回答率は 20.6%とやや低い。つまり,「他者の解説」と「努力」は, A が重視し, そのことを生徒も認識し, さらには, 生徒自身も重視している下位次元ということができる。一方,「自らの探究」は, A は重視しているが, そのことを生徒は認識していないものの, 生徒自身は重視している下位次元ということができる。項目 27 の回答率が低い「過程」に関しては, 項目 28 の回答率も 5.9%と低いことから, A は重視しているが, そのことを生徒は認識しておらず, 生徒自身も重視していない下位次元といえる。

次に, A が重視していない下位次元に注目すると, 生徒用項目 27 に対する回答率の高い下位次元は含まれておらず, 回答率の低い下位次元として「才能」,「厳しさ」,「過程」,「活用」,「数学世界における事実」,「現実世界での使用」,「創造」が含まれている。これらの項目 28 に対する回答率に注目すると, それぞれ 0.0%, 8.8%, 5.9%, 0.0%, 0.0%, 0.0%, 0.0%と低い。つまり, これらの下位次元は, A は重視しておらず, 生徒も A が重視しているとは認識しておらず, 生徒自身も重視していない下位次元といえる。

以上のことを踏まえ, 教師 A の数学授業における生徒の価値観の形成過程パターンを整理すると, 表 12 のようになる。

表 12:教師 A の生徒の価値観の形成過程

形成過程パターン	下位次元
パターン①	努力, 他者の解説
パターン②	―
パターン③	自らの探究
パターン④	過程
パターン⑤	―
パターン⑥	―
パターン⑦	―
パターン⑧	才能, 厳しさ, 活用, 数学世界における事実, 現実世界での使用, 創造

つまり, A の数学授業では,「他者の解説」や「努力」は, 教師が重視し, そのことを生徒も認識したうえで, 生徒の価値観として受入られているといえる。また, A が重視する「自らの探究」に関しては, そうした A の価値観を生徒は認識していないものの, 自分たちの価値観としては受け入れている一方, A が重視する「過程」に関しては, そうした A の価値観を生徒は認識しておらず, 自分たちの価値観としても受け入れてはいない。そして,「才能」,「厳しさ」,「活用」,「数学世界における事実」,「現実世界での使用」,「創造」については, A も生徒も自身の価値観として重視しているとはいえない。

(2) 教師 B とその生徒の価値観の関係

次に, B に関してだが, 質問紙の記述から読み取ることのできた B の価値観として,「努力」,「心地よさ」,「過程」,「結果」,「活用」,「他者の解説」が挙げ

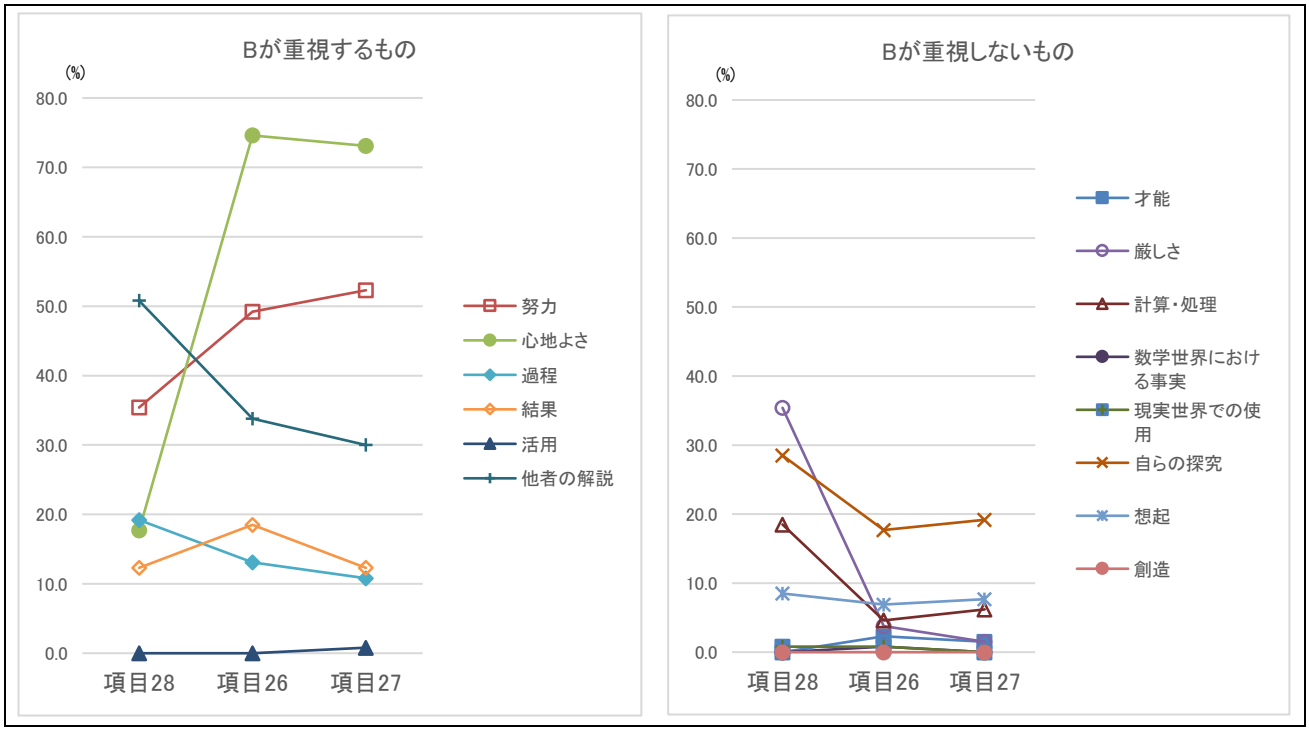

図 3:教師 B の生徒の価値観の形成過程

られる。一方,「才能」,「厳しさ」,「計算・処理」,「数学世界における事実」,「現実世界での使用」,「自らの探究」,「想起」,「創造」は,B が重視するものとして回答記述からは読み取れなかった。そこで,A 同様,B が重視するものとそうでないもの別に,B の生徒の回答率を図 3 のように整理した。

まず,B が重視する下位次元に注目すると,生徒用項目 27 に対する回答率の高い下位次元として「心地よさ」,「努力」,「他者の解説」が,また,回答率の低い下位次元として「活用」が含まれている。項目 27 の回答率の高い下位次元のうち,「努力」と「他者の解説」は,項目 28 に対する回答率も比較的高い(それぞれ 35.4%,50.8%)が,「心地よさ」は項目 28 の回答率が 17.7%とやや低い。つまり,「努力」と「他者の解説」は,B が重視し,そのことを生徒も認識し,さらには,生徒自身も重視している下位次元ということができる。一方,「心地よさ」は,B は重視しているが,そのことを生徒は認識していないものの,生徒自身は重視している下位次元ということができる。項目 27 の回答率が低い「活用」に関しては,項目 28 の回答率も 0.0%と低いことから,B は重視しているものの,そのことを生徒は認識しておらず,生徒自身も重視していない下位次元といえる。

次に,B が重視していない下位次元に注目すると,生徒用項目 27 に対する回答率の高い下位次元は含まれておらず,回答率の低い下位次元として「才能」,「厳しさ」,「数学世界における事実」,「現実世界での使用」,「創造」が含まれている。これらの項目 28 に対する回答率に注目すると,それぞれ 0.0%,35.4%,0.0%,0.8%,0.0%となり,「厳しさ」以外の下位次元の回答率は低い。つまり,「厳しさ」以外のこれらの下位次元は,B は重視しておらず,生徒も B が重視しているとは認識しておらず,生徒自身も重視していないものといえる。ただし,「厳しさ」に関しては,B は重視していないものの,生徒は B が重視していると認識している反面,生徒自身は重視していない下位次元といえる。

以上のことを踏まえ,B の数学授業における生徒の価値観の形成過程パターンを整理すると,表 13 のようになる。

表 13:教師 B の生徒の価値観の形成過程

形成過程パターン	下位次元
パターン①	努力,他者の解説
パターン②	―
パターン③	心地よさ
パターン④	活用
パターン⑤	―
パターン⑥	―
パターン⑦	―
パターン⑧	才能,厳しさ,数学世界における事実,現実世界での使用,創造

つまり,B の数学授業では,「努力」や「他者の解説」は,教師が重視し,そのことを生徒も認識したう

えで，生徒の価値観として受入られているといえる。また，B が重視する「心地よさ」に関しては，そうした B の価値観を生徒は認識していないものの，自分たちの価値観としては受け入れている一方，B が重視する「活用」に関しては，そうした B の価値観を生徒は認識しておらず，自分たちの価値観としても受け入れてはいない。そして，「才能」，「厳しさ」，「数学世界における事実」，「現実世界での使用」，「創造」については，B も生徒も自身の価値観として重視してはいないといえる。

(3) 教師 C とその生徒の価値観の関係

最後に C に関してだが，質問紙の記述から読み取ることのできた C の価値観として，「心地よさ」，「他者の解説」，「自らの探究」が挙げられる。一方，「才能」，「努力」，「厳しさ」，「過程」，「結果」，「活用」，「計算・処理」，「数学世界における事実」，「現実世界での使用」，「想起」，「創造」は，C が重視するものとして回答記述からは読み取れなかった。そこで，C が重視するものとそうでないもの別に，C の生徒の回答率を図 4 のように整理した。

まず，C が重視する下位次元に注目すると，生徒用項目 27 に対する回答率の高い下位次元として「心地よさ」と「他者の解説」が含まれている。このなかで，「他者の解説」は，項目 28 に対する回答率が 49.1%と高いが，「心地よさ」は 6.6%と低い。つまり，「他者の解説」は，C が重視し，そのことを生徒も認識し，さらには，生徒自身も重視している下位次元だが，「心地よさ」は，C は重視しているが，そのことを生徒は認識していないものの，生徒自身は重視している下位次元といえる。

次に，C が重視していない下位次元に注目すると，生徒用項目 27 に対する回答率の高い下位次元として「努力」が含まれており，その項目 28 に関する回答率は 36.8%と高い。つまり，「努力」に関しては，C は重視していないものの，生徒は C が重視していると認識し，生徒自身も重視している下位次元といえる。一方，回答率の低い下位次元として「才能」，「厳しさ」，「活用」，「計算・処理」，「数学世界における事実」，「現実世界での使用」，「想起」，「創造」が含まれており，これらの項目 28 に対する回答率は，それぞれ 0.0%，3.8%，0.9%，0.9%，0.0%，1.9%，6.6%，0.0%と低い。つまり，こうした下位次元は，C は重視しておらず，生徒も C が重視しているとは認識しておらず，生徒自身も重視していないものといえる。

以上のことを踏まえ，C の数学授業における生徒の価値観の形成過程パターンを整理すると，表 14 のようになる。つまり，C の数学授業では，「他者の解説」は教師が重視し，そのことを生徒も認識したうえで，生徒の価値観として受入られているといえる。また，C が重視する「心地よさ」に関しては，そうした

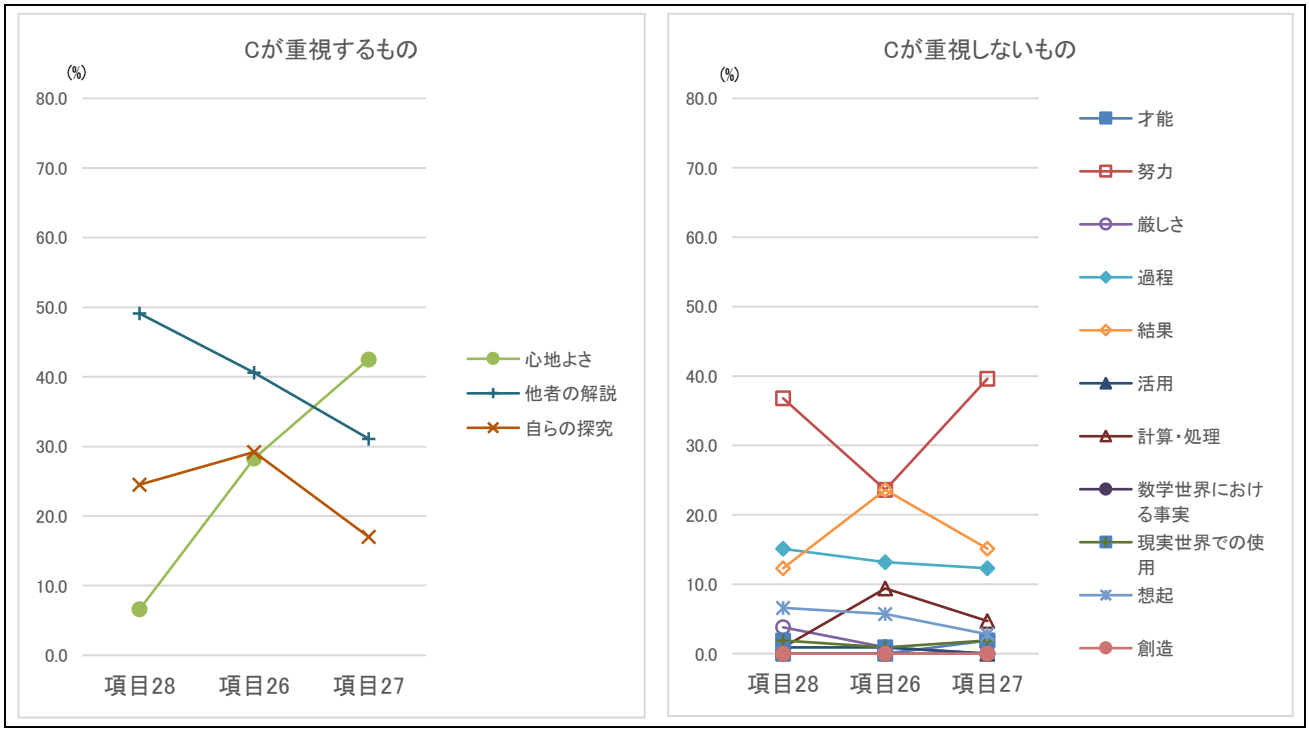

図 4:教師 C の生徒の価値観の形成過程

表 14:教師 C の生徒の価値観の形成過程

形成過程パターン	下位次元
パターン①	他者の解説
パターン②	－
パターン③	心地よさ
パターン④	－
パターン⑤	努力
パターン⑥	－
パターン⑦	－
パターン⑧	才能，厳しさ，活用，計算・処理，数学世界における事実，現実世界での使用，想起，創造

C の価値観を生徒は認識していないものの，自分たちの価値観としては受け入れている。他方で,「努力」に関しては，C は重視していないにもかかわらず，生徒は C の価値観として認識し，自分たちの価値観としても受け入れている。そして,「才能」,「厳しさ」,「活用」,「計算・処理」,「数学世界における事実」,「現実世界での使用」,「想起」,「創造」に関しては，C も生徒も自身の価値観として重視してはいないといえる。

(4) 全体考察

以上の考察を踏まえ，数学教育的価値観の形成過程パターンと数学教育的価値観の下位次元に関する全体的な考察を行う。

① 数学教育的価値観の形成過程パターンについて

今回の 3 事例を通して，図 1 で示した数学教育的価値観の形成過程パターンのうち，①，③，④，⑤，⑧（図 5）を確認することができた。このことは，価値観の形成過程パターンとして，この 5 つが今回の 3 事例においてより妥当であることを示唆している。

このうち，生徒の価値観が形成されるパターンとしては①，③，⑤がある。

パターン①は，教師があるものを重視していることを生徒が認識し，生徒も同じものを重視するようになるという過程であり，教師の価値観が生徒の価値観形成に直接的に影響しているパターンといえる。

パターン⑤は，教師があるものを重視していないにもかかわらず，教師はそれを重視していると生徒が認識し，自分も重視するようになるという過程であり，教師の価値観が生徒の価値観形成に直接的には影響していないパターンといえる。この形成過程には，教師の価値観と生徒の認識の間に乖離があり，教師とは異なる価値観を生徒が有することになる。こうした形成過程が生じる要因としては，無意識のうちに発現する教師の価値観や，学級，学校，地域社会などが有する価値観の影響も考えられる。

また，パターン③は，教師が重視しているものを生徒が認識していないにもかかわらず，生徒も同じものを重視するようになるという過程であり，パターン⑤同様，教師の価値観が生徒の価値観形成に直接的には影響していないパターンといえる。この形成過程では，教師の価値観と生徒の認識の間と，生徒の認識と生徒の価値観の間の 2 箇所に乖離があるにもかかわらず，教師と生徒が同じ価値観を有することになる。教師が有する価値観を生徒にうまく伝えられない，もしくは，意図的に生徒に伝えないために，教師の価値観を生徒が認識できないものの，学級，学

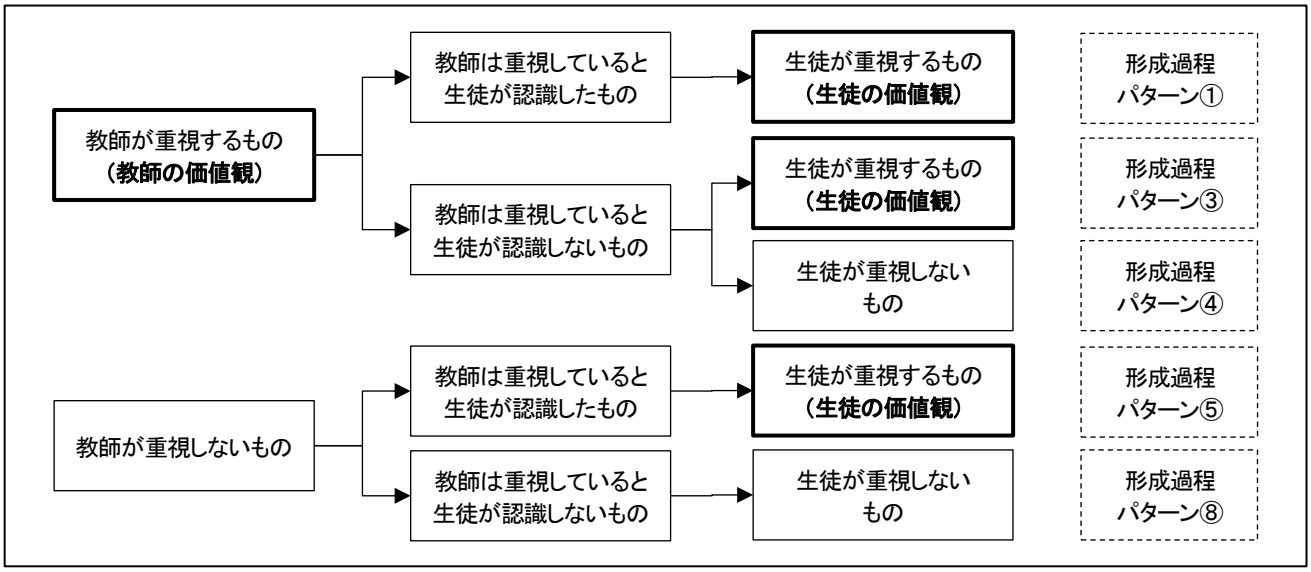

図 5:数学授業における生徒の価値観の形成過程モデル

校，地域社会などが有する価値観の影響を受けて，あるいは，生徒自身の数学学習の経験に基づき，生徒がある価値観を形成した結果，教師と生徒が同じ価値観を有するパターンと考えられる。教師や生徒個人の問題というよりも，彼らが共有する社会的･文化的文脈の影響を受けるパターンとして捉えることもできるかもしれない。

一方，生徒の価値観が形成されないパターンとして，④と⑧がある。

パターン⑧は，教師があるものを重視していないと生徒が認識し，生徒もそれを重視しないようになるという過程である。逆説的ではあるが，教師の価値観が生徒の価値観形成に直接的に影響しているパターンであり，教師自身が有していない価値観は，生徒にも形成されないことを意味する。

パターン④は，教師があるものを重視しているものの，そのことを生徒は認識しておらず，そのため，生徒は同じものを重視しないようになる過程であり，教師の価値観が生徒の価値観形成に影響していないパターンといえる。この形成過程には，教師の価値観と生徒の認識の間に乖離があり，そのことを生徒の価値観形成の阻害要因として捉えることができる。

②　数学教育的価値観の下位次元について

次に，今回の 3 事例で検討した数学教育的価値観の下位次元に関しては，教師から生徒へ引き継がれるものとして，「他者の解説」がすべての事例で確認できた。その一方で，教師も生徒も重視していることが確認できなかったものとして，「才能」，「厳しさ」，「数学世界における事実」，「現実世界での使用」，「創造」があった。

もちろん，本稿で採用した質問紙調査には，教師や生徒が有する価値観を捉える手法としての限界もある。記述数の制限により，重視していても記述できなかったものや，記述による回答のため，無意識のうちに重視しているものは，今回の調査では捉えることはできておらず，回答者が有する価値観の諸相すべてを把握するには至っていない。しかしながら，今回の調査で捉えた価値観の諸相の一面は，回答者により強く意識されたものと見なすことができる。そうした点では，「才能」，「厳しさ」，「数学世界における事実」，「現実世界での使用」，「創造」という下位次元は，相対的にはあまり意識されていないものとして見なすことができる。こうした下位次元を，教師も生徒もより強く意識するようになることは，数学的な見方や考え方を働かせ，数学的活動を通して数学的に考える資質･能力の育成を目指す，これからの数学教育においての課題ということもできる。特に，「数学世界における事実」，「現実世界での使用」，「創造」といった価値観を生徒がどのように形成できるようになるか，検討すべき課題といえよう。

7. おわりに

本稿では，国際比較調査「第三の波」が開発した *WIFItoo* を用いた質問紙調査で収集した宮崎県データの一部を分析し，生徒と教師の価値観の関係の特徴を明らかにすることを目的とした。

その結果，3 名の教師の事例に関する考察を行い，それぞれの教師と生徒の価値観の関係の特徴や，数学授業における価値観の形成過程の特徴の一端を明らかにした。また，3 事例に共通する特徴として，数学教育的価値観の下位次元のうち，「他者の解説」は教師から生徒へ引き継がれるが，「才能」，「厳しさ」，「数学世界における事実」，「現実世界での使用」，「創造」は教師にも生徒にも受け入れられなかったことや，価値観の形成過程パターンとして①，③，④，⑤，⑧が妥当であることが明らかとなった。

しかしながら，調査対象者の人数が少ないため，3 事例から導出した結論を，宮崎県全体の特徴として一般化するのは早計であろう。本校の調査を予備的調査と位置づけ，調査対象者を増やし，他の研究対象地域の事例も含めたデータ分析や，質問紙 *WIFItoo* の他の項目の回答に関する分析も行うなどして，本稿の結論についての検討を今後の課題としたい。

また，今回は生徒を集団として見なし，価値観の形成過程を考察したが，個人としての形成過程にまで分析が及んでいない。そして，実際の数学授業における教師と生徒の社会的相互作用についても考察はできていないため，変容過程の内実を捉えるには十分とは言えないと考える。そうした点は，本研究の 2 つ目の課題である授業分析やインタビュー調査を通して解明を目指す。

さらに，本稿で提案した数学授業における生徒の価値観の形成過程モデルや数学教育における価値観の概念枠組みの検討，記述分析における定性的コーディングの検討といった，研究手法に関する課題もある。今回の考察では，教師の価値観の影響に焦点を当てていたが，生徒が独自で見出した価値観やその形成過程についても検討の余地がある。

最後に，本稿の事例では，教師と生徒の両者で意識されなかった価値観，中でも，日本の数学教育において重視されていると思われる，数学世界における事

実，現実世界での使用，創造といった価値観を，生徒の価値観としてどのように形成していくべきかを検討することも必要であろう。

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Study on the Influences of Teacher's Value on the Formations of Students' Values in Mathematics Education (1)

Data Analysis of Questionnaire Survey in Miyazaki Prefecture Using the Questionnaire "*WIFI too*" Developed by International Comparative Study "The Third Wave"

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Abstract

The purpose of this study is to identify the characteristics of the processes of students' value formations and the influences of their teachers' values on the students' value formations in mathematics education in Japan. This study is conducted as a part of International Comparative Study "The Third Wave".

This paper shows the data analysis of questionnaire survey in Miyazaki prefecture using the questionnaire "*What I Find Important (in mathematics learning) too*" (*WIFI too*) developed by "The Third Wave". The survey was conducted for 3 junior high school mathematics teachers and their students in Miyazaki prefecture.

Through the data analysis using the dimension "Mathematics educational values" in the conceptual framework "Values in mathematics education" developed by "The Third Wave", the followings were found as common characteristics among the cases of the 3 teachers and their students: the sub-dimension "Exposition" in the dimension "Mathematics educational values" was shared by both teachers and students; and the sub-dimensions "Ability", "Hardship", "Facts/Truths", "Ideas/Practice" and "Creating" were not shared by both teachers and students. In addition, the following patterns were found as possible processes of students' value formations: 1) teacher has a value, students recognize that the teacher has the value, then students also have the value; 2) teacher has a value, students do not recognize that the teacher has the value, but students have the value; 3) teacher has a value, students do not recognize that the teacher has the value, then students do not have the value; 4) teacher does not have a value, but students recognize that the teacher has the value, then students have the value; and 5) teacher does not have a value, students do not recognize that the teacher has the value, then students also do not have the value.

APPENDIX 3: ENGLISH, TRANSLATED VERSION OF JOURNAL ARTICLE WRITTEN BY OUR JAPANESE TEAM

The Influences of Teacher Valuing on the Development of Student Valuing in Mathematics Education (1)

Data Analysis of Questionnaire Survey in Miyazaki Prefecture Using the Questionnaire WIFItoo Developed by International Comparative Study The Third Wave

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1. Introduction

In the latest revision of the Course of Study in Japan, the perspectives and ways of thinking pertinent to each subject were emphasized, and knowledge and skills, abilities to think, make judgements and express themselves, and motivation to learn and humanity were indicated as competencies necessary for living in the age of knowledge-based society. These trends mean that the way of understanding the competencies to be fostered has shifted from a prejudiced perspective focusing on cognitive aspects such as knowledge and skills to a more comprehensive perspective including affective aspects and collaboration with others (Matsuo,2016).

On the other hand, the actual states of Japanese students concerning mathematics learning, for example, as can be seen from the results of TIMSS and PISA, is that their interest and feeling of usefulness to mathematics, self-affirmation and self-confidence are low, although they have a high ability in cognitive aspects. it is not a desirable situation. Although such gap between cognitive and affective aspects has been recognized for many years as an issue in mathematics education in Japan, it has not yet been fully overcome (Watanabe, 2012).

In the mathematics education research on affective aspect in Japan, the basic scientific study which analyze the actual condition of learner's affective aspects such as emotion, belief and attitude to mathematics learning, the educational practical study on teaching methods and evaluation in order for learners to acquire desired affective aspects and the wide-area research study to examine future state of learners' affective aspects from the result of national and international survey have been conducted up to now. However, it has been pointed out as future issues to relate affective and cognitive aspects and to establish research methods for such relating (Imai, 2010).

On the other hand, in international mathematics education research, there have been attempts to grasp affective aspects in mathematics learning more multifacetedly, such as that the conceptual frameworks which include dimensions such as cognition-motivation-emotion, state and trait aspects, and physiological-psychological-social aspects have been proposed (Hannula, 2011). In addition, it has been argued that there is a need for research focusing on synergistic relationships with cognition, motivation, and emotion that have been handled individually until then (Hannula, 2012).

In recent mathematics education research, "valuing" has been captured as an element of stable motivational trait (Hannula, 2012), and has attracted attention as one that positions in deep psyche of human being, influences individual decision-making and behavior, and bridges cognitive and affective aspects. And, as a representative study on valuing, the international comparative study "The Third Wave" is been conducted in which research teams of 11 countries/regions including Japan participate (Seah *et al*.201; Seah, 2013a; Seah *et al*., there is a 2017).

This international comparative study focuses on valuing as a third research approach, following cognitive and affective aspects, and aims to clarify the valuing shared by teachers and students in mathematics education in each country and region and their formation processes (socio-cultural context, social interaction in mathematics class, etc.), and to derive their commonality and uniqueness through international comparisons. In this study, the actual states of valuing of mathematics teachers and students in each country and region have been clarified through lesson analysis and questionnaire surveys (Seah & Wong, 2012).

In Japan, the following points have been clarified by questionnaire surveys of elementary and junior high school students

in five prefectures (Akita, Saitama, Osaka, Hiroshima, and Miyazaki). First, various ideas and correct understanding in mathematics learning, essence of mathematics, visible results of mathematical learning, intervention of others in mathematics learning, clues to solve problems, and use of ICT and calculator in mathematical learning were derived as factors that make up the valuing of Japanese students (Kinone *et al*.,2013; Shinno *et.al*., 2014; Ninomiya *et al*., 2015). Next, through the comparison between elementary and junior high schools, it was derived that elementary school students tend to value self-solving of problems, manipulation and activity in mathematical learning, and mysteries and logic related to mathematics, and junior high school students tend to value the results of problem solving. And through the comparison between schools in urban and rural areas, it was derived that students in urban areas tend to value activities and proficiency in mathematical learning (Baba, 2013; Kinone, 2013; Shinno, 2013). In addition, as a characteristic of elementary school students in Akita who perform high achievement in the National Assessment of Academic Ability, it was derived that students in Akita tend to value the intervention of others in mathematics learning more than other prefectures, and it was presumed that the cause was the lessons based on students own learning from each other that are introduced all over Akita prefecture (Ninomiya et al., 2015).

Although these results are limited, they suggest the facts that the valuing of Japanese students have beeing accepting mathematical thinking that mathematics education in Japan has emphasized for a long time and that there was a relationship between academic ability and valuing that emphasizes interactive learning. However, the process of the formation of students' valuing has not been fully clarified, and its clarification is an urgent issue toward the elimination of the gap between cognitive and affcetive aspects.

The "What I Find Important (in mathematics learning) too" (WIFItoo) study, which began in 2017, aims to deepen our understanding of how mathematics teachers in each participating economy deal with diverse valuing in their mathematics lessons for high-quality learning. To this end, a questionnaire for comparing what teachers and their students value was developed.

The purpose of this study is to identify the formation and its process of students' valuing in mathematics learning and the influences of their mathematics teachers on the formation in Japan. For this purpose, the 7 target prefectures were selected (Hokkaido, Akita, Saitama, Tokyo, Osaka, Hiroshima and Miyazaki), and the following research questions were set:

1. What is the characteristic of the relations between students' and teachers' valuing? (questionnaire survey)
2. What is the process of the formations of students' valuing in mathematics learning and what is the influence of teachers on the formations? (lesson analysis, interview investigation)
3. What is the characteristic of the formations of students' values in mathematics learning and what is the influence of teachers on the formations in Japan? (International comparisons)

This paper reports the result of a part of the WIFItoo questinaire survey conducted in Miyazaki prefecture (R.Q. 1). Firstly, the framework of Values in Mathematics Education established in the Third Wave Project and the questinaire WIFItoo developed for the comparison of valuing of tachers and students in mathematics education are reviewed. Secondly, a part of the collected data of the questionnaire survey in Miyazaki prefecture is analized. Then, the characteristic of the relations between students' and teachers' valuing is discussed.

2. Framework of Values in Mathematics Education

In the Third Wave Project, the Values in Mathematics Education is defined as "the personal convictions which a person regards as being important in facilitating the learning or teaching of school mathematics" (Seah and Peng, 2012, p.73). The conceptual framework of Values in Mathematics Education consists of three "dimensions": Mathematical Values, Mathematics Educational Values and Cultural and General Educational Values based on Bishop (1988) and Hofstede and Hofstede (2005) (Seah, 2013; Andersson & Österling, 2013).

According to Seah (2013b), the mathematical values are defined as "the convictions that have been emphasised in the tradition of 'Western' mathematics" (p.194). The sub-dimensions of these values are, based on Bishop (1988), three pairs of complementary mathematical values, namely *rationalism* and *objectism*, *control* and *progress*, and *mystery* and *openness*.

Seah (2013b) also mentioned that the general educational values are "what the education system wishes to inculcate

amongst the students" and "may be the school values, and may also be the national values which exist in some cultures" (p.194). The sub-dimensions of cultural and general educational values are put such values as power distance, individualism and collectivism, masculinity and femininity, uncertainty avoidance, long/short-term orientation, and inclusiveness.

And, the Mathematics Educational Values are recognised as values particular to mathematics lessons (learning and teaching) at school education, such as that "are specifically associated with the norms of the institutions within which mathematics education is formally conducted" (Seah & Bishop, 2002), "arise from the situation of teaching mathematics in school classrooms" (Clarkson et al., 2000, p.188), "are expressed through the pedagogical practices of the subject in schools" (Seah, 2013b, p.194) and so on.

While acknowledging that there is a huge range of attributes in mathematics pedagogy which are the mathematics educational values, this paper adopts the seven pairs of mathematics educational values that were used in the formulation of the WIFI questionnaire, used in the WIFI study conducted earlier (Kinone & Seah, 2015). Like the three pairs of mathematical values mentioned above, these seven pairs of mathematics educational values can be seen to exist in complementary ways. In other words, it would not be often for one to find someone who values one of the two values only in any complementary pair. Rather, we would likely value one value more than the other. This is why the complementary values are presented in the form of value continua in the WIFI questionnaire. These mathematics educational values are, namely, *ability* and *effort*, *wellbeing* and *hardship*, *process* and *product*, *application* and *computation*, *facts* and *ideas*, *exposition* and *exploration*, as well as *recalling* and *creating*. The authers examined the meanings of each value continua based on prior research related to the Third Wave Project, and Table 1 summarises what each mathematics educational value will be taken to mean in the present study being reported in this paper.

Table 1: Sub-Dimensions of Mathematics Educational Values

	Sub-Dimension	Content
1	Ability	Valuing special talent (ability) in mathematics learning
	Effort	Valuing effort in mathematics learning
2	Wellbeing/Comfort	Valuing calm, comfortable and enjoyable situation and atmosphere in mathematics learning
	Hardship	Valuing hard, difficult or tension-filled situation and atmosphere in mathematics learning
3	Process	Valuing process in mathematics learning
	Product	Valuing product (result) in mathematics learning
4	Application	Valuing application of mathematics in various problematic situations in mathematics learning
	Computation	Valuing computation and calculation in mathematics learning
5	Facts/Truths	Valuing facts (truths) in mathematics world in mathematics learning
	Ideas/Practice	Valuing ideas on the ways of using mathematics in real world in mathematics learning
6	Exposition	Valuing that others such as teacher and classmates teach mathematics in mathematics learning
	Exploration	Valuing mathematics learning by learners themselves including collaboration with classmates (valuing autonomous learning).
7	Recalling	Valuing remembering mathematical knowledge given by others exactly in mathematics learning
	Creating	Valuing constructing mathematical knowledge by learners themselves in mathematics learning

(Kinone & Seah, 2015, p.100)

3. The WIFItoo questionnaires

The questionnaire WIFItoo was developed as for teacher and students separately. It is supposed to identify the similarities and differences between the valuing of teacher and his/her students, and the relations of teacher's and students' valuing through comparing the responses from both teacher and student questionnaires.

The teacher questionnaire (T.Q.) consists of 36 question items. The items 1 to 17 are about personal information including working school, medium of instruction, home town, gender, age, teaching experience and so on. The items 18 to 21 ask to write what are important things in learning and teaching mathematics in three free descriptive answers (Table 2). The items 22-34 ask to write situations where there is a gap between what a teacher and their students think are important in mathematics lessons implemented. And items 35-36 are about contact details.

Table 2: Items 18-21 in WIFItoo Teacher Questinaire

Item	Question
18	When anyone learns mathematics, what do you think are the important things that help him/her to learn?
19	When anyone teaches mathematics, what do you think are the important things that help him/her to teach?
20	When I learn mathematics, what are the important things that help me to learn?
21	When I teach mathematics, what are the important things that help me to teach well?

On the other hand, the student questionnaire (S.Q.) consists of 32 question items. The items 1 to 14 are about personal information including school, medium of instruction, famity, age, gender and so on. The items 15 to 25 ask respondents to specify their level of agreement selecting Likert-scale items with four choices on the usefulness and necessity of athematics learning, what is important in learning mathematics, and so on. The items 26-28 ask students to write what students themselves and their teacher think are important things in learning and teaching mathematics in three free descriptive answers (Table 3). And the items 29-32 ask to write situations where there is a gap between what a teacher and their students think are important in mathematics lessons participated.

Table 3: Items 26-28 in WIFItoo Student Questinaire

Item	Question
26	When anyone learns mathematics, what do you think are the important things that help him/her to learn?
27	When I learn mathematics, what are the important things that help me to learn?
28	Think about your mathematics teacher this year. What do you think are important to him/her in mathematics teaching?

As the WIFItoo questionnaire is written in English, the authers translated into Japanese as follows. Firstly, three Japanese research members translated the questionnaire into Japanese individually, and they compared their translations and made a draft of WIFItoo questionnaire in Japanese. Secondly, another Japanese research member different from the three translated the draft in Japanese into English (back-translation). Then, the study leader (Dr. Seah, W. T.) compared the back-translationa and the original questionnaire. As the result, it was confirmed that the translatin into Japanese was reflected enough in the original of the WIFItoo questionnaire.

In this paper, the focus is on the items asking teachers and their students to write what are important things in learning and teaching mathematics, such as T.Q. items 18-21 and S.Q. items 26-28.

4. Research Method

(1) Participants

The aim of the WIFItoo questionnaire survey is to identify the influence of excellent mathematics teachers on the development of students' valuing through mathematics lessons in each participating country/region.

In the case of the survey in Miyazaki prefecture, the criteria of selecting excellent mathematics teacher was set as follows: having more than 10 years teaching experiences; being regarded as teachers dedicating to mathematics lessons; and having research experiences at research institution (master student, research trainees and so on). As a result, three mathematics teachers (Teacher A, B, C) were selected from each of three education administrative regions in Miyazaki. The basic information on the selected teachers and the number od their students and classes are as Table 4.

Table 4: Basic Information of Selected Teachers

Teacher	Gender	Age	Teaching Experiences	Class	No. of Students	Total
A	Female	44	22 years	Grade 2 (2 classes)	34	34
B	Male	41	18 years	Grade 1 (1 class)	28	130
				Grade 2 (3 classes)	102	
C	Male	39	15 years	Grade 1 (2 classes)	46	106
				Grade 3 (2 classes)	60	

(2) Data Collection

The procedure of data collection was as follows. Firstly, the research members explained the purpose and concrete acivity of the questionnaire survey to the teacher participants. Secondly, these teacher participants distributed the questionnaire to their students and invited them to respond to the questionnaire during designated time during the respective mathematics lessons. The teachers were requested not to give extra explanation to their students during their writing in the questionnaire.

The explanation of the survey to the teachers was done in the beginning of March, 2018, and the collection of the question paper went in the end of March, 2018.

(3) Data Analysis

The respopnses written in the T.Q. and S.Q. questionnaires were analysed as follows, with the help of the qualitative data analysis computer software NVivo 12.

Firstly, teachers' responses to T.Q. items 18-21 were classified into the sub-dimensions of mathematics educational values considering the meanings of all responses indicated in the questionnaire.

Secondly, each of students' responses were summarized and added open codes, paying attention to symbolic words in their descriptions and considering their intention and background. For example, the descriptions "formula of mathematics" and "way of calculating"

For example, the descriptions "formula of mathematics" and "way of calculating" were given the open code "Procedure/ method/ way of solution/ formula", because it was considered that the respondants could value procedural knowledge such as formula and method. The description "to remember formulas" was given two open codes "Procedure/ method/ way of solution/ formula" and "Memorizing formula", because it was considered that the respondants could value memorization as a way of learning formulas in addition to formula as a content of learning. Furthermore, there were many discriptions regarding relationship with others such as teacher and friends, but those discriptions were categorized into some groups. Some were about comfortable human relationship, some were about the existence of others who teach learning content that the respondents don't understand, and some were about collaboration with others for solving problems together. Then, the first group was given the open code "Human relationship", the second was given "Quality of explanation", and the third was given "Group exploration".

Thirdly, the open codes were categorized into the sub-dimensions of mathematics educational valuing, the original descrriptions in each of sub-dimension of mathematics educational valuing were comparerd continually in order to examine the validity of open coding and categorization into the sub-dimensions, and the modification of the open coding and the categorization was conducted.

For example, the open codes "Comfortable environment" given to the descriptions valuing textbooks and stationery necessary for comfortable learning, "Human relationship" given to the descriptions valuing good relationships with teachers who teach things they don't understand and friends who learn together, and "Rest" and "Meal/snack" given to the descriptions valuing rest and snacks to study calmly were categorized into the sub-dimension *Wellbeing/Comfort*, bacause those open codes were related to a valuing on a comfortable learning environment and atmosphere that can be calm and enjoyable to learn.

As a result, the correspondence between the sub-dimension of mathematics educational valuing and the open codes came up to Table 5.

Table 5: Correspondence between Sub-dimension of Mathematics Educational Values and Open Codes

	Sub-Dimension	Open code	Examples of descriptions
1	Ability	Brain, Perception, Sense, Talent, Intelligence	"Intelligence. The reason is that it is not possible to calculate if there is no intelligence to think.", "Brain", "Sense", "Feeling", "Talent"
	Effort	Conation/autonomy/patience, Exercise/practice, Revision, Concentration, Note writing, Preparation for lesson, Effort, Small step, Carefulness, Reviewing, Attitude, Tutoring school, Continuance, Confidence, Sense of accomplishment, Calm	"If there are things that I don't understand, and I leave them, I won't be able to do more. So I'll try to solve even if I don't know.", "Motivation. If you don't get motivated, it won't start.", "Concentration. If you don't concentrate, you won't be able to study."
2	Wellbeing /Comfort	Comfortable environment (textbook, reference book, print, stationary, facility, calculator, PC, tablet, atmosphere, internet, music/BGM), Human relationship (person who teaches, friends, encouragement/snuggle, partnaership, mutual recognition, easiness to say, communication), Time, Rest, Easiness/convenience, Reward, Meal/snack	"Textbook. If you study while looking at a textbook, you'll know.", "Belongings. If people use writing instruments that are easy to use for them, it will be a chance for them to get motivated.", "Consideration from surrounding persons. If anyone doesn't teach you what you don't understand, you never understand it.", "Friends. They help me when I don't understand.", "To create an environment that makes it easier to aks things you don't understand.", "To take the other person's position. Not to teach looking down on someone absolutely." "Food (and music too). I can concentrate on eating what I like."
	Hardship	Strictness/discipline, Pace of lesson, Consciousness of entrance examination/test, Imposition, Friendly competition, Standardizing, Difficult problem, Ability improvement, Training	"To understand enough so that I could not have to listen to the same thing over and over." "To listen. I believe it is important to listen even if I don't understand." "Whether everyone raises teir heads or not when someone speaks something important.", "To work hard together by comparing your strength with your friends."
3	Process	Understanding, Way of thinking, Process, Reason, Wisdom/point	"Ability of understanding. I believe it's important to understand first.", "Explanation of why it is the answer."
	Product	Procedure/method/way of solution/formula, Base/foundation, Knowledge (term/word), Correct answer	"I'll make a drawer in my head so that I can remember formulas and use them at any time.", "When I don't undestand, I look at answers and solve many times."
4	Application	Applied exercise, Application, Utilization	"To give application problems. Not only basics, but also practice of application.", "Ability of application. I will try to be able to solve difficult problems."
	Computation	Calculation/computation, Speed, Accuracy, Simplicity/ease, Solving problem	"Ability of computing. You can calculate quickly and solve problems quickly." "To solve (formula) as easily as possible."
5	Facts/Truths	Pattern	"Regularity. If you know a regularity, you will understand things beyond it sometimes."
	Ideas/Practice	Use in daily life, Familiar example, Necessity of mathematics, Mathematics in problem	"Some cases when we use for work such as daily life in future.", "Application. I think I can use it for my daily life."
6	Exposition	Quality of explanation (easiness to understand, teaching until I know, way of teaching, individually targeted teaching, easiness to listen/volume of voice, carefulness, equally teaching, enthusiasm, accuracy/correctness, visibility of writing on blackboard, expression), Way of explanation (explaining, use of diagram/table, using a metaphor with familiar things, gesture, writing on blackboard, using ICT), Content of explanation (hint/advise, procedure, points, things I don't understand, answers, knowledge, various solving methods, basic, confirming previous knowledge)	"They teach those who don't understand individually.", "They teach slowly and carefully", "Easy to understand. To teach in a concise and easy-to-understand manner to suit us.", "They teach until we understand. If you leave it without understanding, you will never understand.", "Advice. They teach somewhere you don't understand.", "Someone who understands teaches points to you, and you solve some questions together.", "Someone who understands explains to those who don't understand.", "Your friend teaches. You don't have to leave it without understanding, your friend teaches it." "Someone teaches me. If I don't understand, I ask those who understand to teach it so that I understand it.", "They teach something I don't understand in detail by using diagrams and so on.", "Example. When solving difficult problems, it is easy to understand if you teach them using things etc. rather than head.", "They explain using a tablet etc."
	Exploration	Individual expolation (thinking/solving/doing by oneself, curiosity, interst of mathematics, reading textbook/document, expression/presentation, various ways of thinking, use of tools, use of ICT, experiment/experience), group exploration (mutual cooperation, discussion, thinking together, collaboration, comparison of thinkings)	"To work with one's own ideas", "To think about it from various perspectives", "By myself. When a problem comes up that I can't solve, it's hard to feel fine unless I solve it somehow by thinking hard.", "Students should find answers by themselves." "To teach and listen to things you don't understand each other.", "Cooperation. We should discuss what we don't understand by talking.", "To share your opinion. If you have various opinions, you can use them."
7	Recalling	Memorizing formula, Memorizing, Memorizing basic/foundation, Memorizing terms/words, Memorizing procedure	"To remember formulas.", "You should remember how to calculate properly.", "To remember proof and so on quickly."
	Creating	-	-

5. Results

We are going to show the result of the data analysis described above on the case of each teacher separately. Firstly, the responses of the target teacher are shown and the characteristics of the responses are described. Secondly, the result of the coding of the students'responses to the S.Q. items 26-28 are organized into the sub-dimensions of mathematics educational valuing, the ratios of the students in each of the sub-dimensions are calculated, and the characteristics of the ratios are described.

(1) Case of Teacher A and Her Students

(a) Responses from Teacher A

The responses of Teacher A to T.Q. items 18-21 were shown in Table 6.

Table 6: Description of Teacher A

	General opinion	Personal opinion
Mathematics learning	Item 18: • Acquisition of basic knowledge and skills including formulas and definitions • Many approaches (Abundance of knowledge) • Calculation skills	Item 20: • Basic knowledge and skills • Abundance of knowledge • Flexible thinking
Mathematics teaching	Item 19: • Abundance of knowledge • Flexible thinking • Ability to express in order for students to understand	Item 21: • Study of learning contents (discussion with colleagues) • Abundance of knowledge • Understanding students

One of the characteristics of the responses of Teacher A is a tendency to value *Product*, since there were many comments on basic knowledge, definision and formula in the responses. And there is also a tendency to value *Process* since Teacher A mentioned flexible thinking and study of learning contents as mathematics teacher in her responses. We also find a tendency to value *Exposition* as one of her characteristics since there are descriptions on ability to express in order for students to understand and many approaches of teaching. In addition, it seems that she tends to value *Effort*, *Wellbeing/Comfort*, *Computation* and *Exploration*, seeing the discriptions on the acquisition of basic knowledge and skill, understanding students for the development of better human relationships with students, calculatin skills and study of learning contents and discussion with colleagues respectively.

Therefore, *Product*, *Process*, *Exposition*, *Effort*, *Wellbeing/Comfort*, *Computation* and *Exploration* are identified as components of Teacher A's valuing.

(b) Responses from Students of Teacher A

The number and ratio of students in the results of coding for S.Q. items 26-28 are shown in Table 7.

Table 7: Responses from Students of Teacher A (Grade 2: 34 students)

	Sub-dimension	Item 26		Item 27		Item 28	
		No.	%	No.	%	No.	%
1	Ability	0	0.0	0	0.0	0	0.0
	Effort	6	17.6	11	32.4	15	44.1
2	Wellbeing /Comfort	8	23.5	8	23.5	6	17.6
	Hardship	0	0.0	0	0.0	3	8.8
3	Process	4	11.8	1	2.9	2	5.9
	Product	10	29.4	7	20.6	12	35.3
4	Application	0	0.0	0	0.0	0	0.0
	Computation	5	14.7	5	14.7	2	5.9
5	Facts/Truths	0	0.0	0	0.0	0	0.0
	Ideas/Practice	0	0.0	1	2.9	0	0.0
6	Exposition	17	50.0	14	41.2	15	44.1
	Exploration	12	35.3	17	50.0	7	20.6
7	Recalling	6	17.6	6	17.6	8	23.5
	Creating	0	0.0	0	0.0	0	0.0

Firstly, the result of data analysis on the item 26 shows that the sub-dimensions with higher ratio of responses relatively are *Exposition* (50.0%), *Exploration* (35.3%) and *Product* (29.4%). Then, these sub-dimensions are valued by the students of Teacher A as general opinions. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (0.0%), *Hardship* (0.0%), *Application* (0.0%), *Fact/Truths* (0.0%), *Ideas/Practice* (0.0%) and *Creating* (0.0%). Then, these sub-dimensions are not valued by the students of Teacher A as general opinions.

Secondly, the result of data analysis on the item 27 shows that the sub-dimensions with higher ratio of responses relatively are

Exploration (50.0%), *Exposition* (41.2%) and *Effort* (32.4%). Then, these sub-dimensions are valued by the students of Teacher A as personal opinions. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (0.0%), *Hardship* (0.0%), *Process* (2.9%), *Application* (0.0%), *Fact/Truths* (0.0%), *Ideas/Practice* (2.9%) and *Creating* (0.0%). Then, these sub-dimensions are not valued by the students of Teacher A as personal opinions.

And, the result of data analysis on the item 28 shows that the sub-dimensions with higher ratio of responses relatively are *Effort* (44.1%), *Exposition* (44.1%) and *Product* (35.3%). Then, these sub-dimensions are recognized by the students of Teacher A as what Teacher A values. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (0.0%), *Application* (0.0%), *Fact/Truths* (0.0%), *Ideas/Practice* (0.0%) and *Creating* (0.0%). Then, these sub-dimensions are not recognized by the students of Teacher A as what Teacher A values.

(2) Case of Teacher B and His Students

(a) Responses from Teacher B

The responses of Teacher B to T.Q. items 18-21 were shown in Table 8.

Table 8: Description of Teacher B

	General opinion	Personal opinion
Mathematics learning	Item 18: - Knowledge learnt in previous learning. To make use of known and pre-learned content. - Textbook. What you have learnt and what you are going to learn are written, and you can prepare and review. - Heart. Heart of trying to know and understand.	Item 20: - Textbook. It is easy to prepare and review. - Reference book. Advices on solving methods are written. - Videos such as Youtube.
Mathematics teaching	Item 19: - Textbook. It is the basis of what needs to be taught, and there are no mistakes in the content. - Videos such as Youtube. It is helpful when you don't know how to teach. - To ask teachers around what you don't understand.	Item 21: - Textbook. It becomes sources when students learn. - Course of study. It shows content to teach and its systems in details. Systems. - Teachers arround such as senior teachers.

One of the characteristics of the responses of Teacher B is a tendency to value *Wellbeing/Comfort*, since Teacher B mentioned in his responses regarding comfortable environment easy to gather information on teaching and learning such as textbook, the course of study and internet, and regarding the existence of colleagues to consult. We also find a tendency to value *Effort* as one of his characteristics, since there are descriptions on heart of trying to know and understand, and on preparation and review. And, it seems that he tends to value *Product*, *Exposition*, *Process* and *Application*, seeing the discriptions on ways of solving problems and previous knowledge, ways of teaching and request of explanation on questions, understanding of learning content, and application of previous knowledge respectively.

Therefore, *Wellbeing/Comfort*, *Effort*, *Product*, *Exposition*, *Process* and *Application* are identified as components of Teacher B's valuing.

(b) Responses from Students of Teacher B

The number and ratio of students in the results of coding for S.Q. items 26-28 are shown in Table 9.

Firstly, the result of data analysis on the item 26 shows that the sub-dimensions with higher ratio of responses relatively are *Wellbeing/Comfort* (74.6%), *Effort* (49.2%) and *Exposition* (33.8%). Then, these sub-dimensions are valued by the students of Teacher B as general opinions. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (2.3%), *Hardship* (3.8%), *Application* (0.0%), *Computation* (4.6%), *Fact/Truths* (0.8%), *Ideas/Practice* (0.8%) and *Creating* (0.0%). Then, these sub-dimensions are not valued by the students of Teacher B as general opinions. In addition, comparing between grades, the sub-dimensions whose ratio of responses increasing from grade 1 to 2 are *Effort* (7.2% up) and *Wellbeing/Comfort* (13.2% up), and the ones whose ratio of responses decreasing from grade 1 to 2 are *Exposition* (11.5% down) and *Exploration* (18.4% down).

Table 9: Responses from Students of Teacher B (Grade 1: 28 students; Grade 2: 102 students)

	Sub-dimension	Item 26						Item 27						Item 28					
		Grade 1		Grade 2		Total		Grade 1		Grade 2		Total		Grade 1		Grade 2		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	Ability	0	0.0	3	2.9	3	2.3	0	0.0	2	2.0	2	1.5	0	0.0	0	0.0	0	0.0
	Effort	10	35.7	54	52.9	64	49.2	13	46.4	55	53.9	68	52.3	3	10.7	43	42.2	46	35.4
2	Wellbeing /Comfort	18	64.3	79	77.5	97	74.6	19	67.9	76	74.5	95	73.1	10	35.7	13	12.7	23	17.7
	Hardship	0	0.0	5	4.9	5	3.8	1	3.6	1	1.0	2	1.5	8	28.6	38	37.3	46	35.4
3	Process	3	10.7	14	13.7	17	13.1	3	10.7	11	10.8	14	10.8	6	21.4	19	18.6	25	19.2
	Product	7	25.0	17	16.7	24	18.5	4	14.3	12	11.8	16	12.3	4	14.3	12	11.8	16	12.3
4	Application	0	0.0	0	0.0	0	0.0	1	3.6	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0
	Computation	0	0.0	6	5.9	6	4.6	0	0.0	8	7.8	8	6.2	0	0.0	24	23.5	24	18.5
5	Facts/Truths	1	3.6	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Ideas/Practice	1	3.6	0	0.0	1	0.8	0	0.0	0	0.0	0	0.0	1	3.6	0	0.0	1	0.8
6	Exposition	12	42.9	32	31.4	44	33.8	9	32.1	30	29.4	39	30.0	18	64.3	48	47.1	66	50.8
	Exploration	9	32.1	14	13.7	23	17.7	4	14.3	21	20.6	25	19.2	7	25.0	30	29.4	37	28.5
7	Recalling	3	10.7	6	5.9	9	6.9	5	17.9	5	4.9	10	7.7	4	14.3	7	6.9	11	8.5
	Creating	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Secondly, the result of data analysis on the item 27 shows that the sub-dimensions with higher ratio of responses relatively are *Wellbeing/Comfort* (73.1%), *Effort* (52.3%) and *Exposition* (30.0%). Then, these sub-dimensions are valued by the students of Teacher B as personal opinions. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (1.5%), *Hardship* (1.5%), *Application* (0.8%), *Fact/Truths* (0.0%), *Ideas/Practice* (0.0%) and *Creating* (0.0%). Then, these sub-dimensions are not valued by the students of Teacher B as personal opinions. In addition, comparing between grades, the sub-dimensions whose ratio of responses decreasing from grade 1 to 2 are *Recalling* (13.0% down).

And, the result of data analysis on the item 28 shows that the sub-dimensions with higher ratio of responses relatively are *Exposition* (50.8%), *Effort* (35.4%), *Hardship* (35.4%) and *Exploration* (28.5%). Then, these sub-dimensions are recognized by the students of Teacher B as what Teacher B values. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (0.0%), *Application* (0.0%), *Fact/Truths* (0.0%), *Ideas/Practice* (0.8%) and *Creating* (0.0%). Then, these sub-dimensions are not recognized by the students of Teacher B as what Teacher B values. In addition, comparing between grades, the sub-dimensions whose ratio of responses increasing from grade 1 to 2 are *Effort* (31.4% up) and *Computation* (23.5% up), and the ones whose ratio of responses decreasing from grade 1 to 2 are *Wellbeing/Comfort* (23.0% down) and *Exposition* (17.2% down).

(3) Case of Teacher C and His Students

(a) Responses from Teacher C

The responses of Teacher C to T.Q. items 18-21 were shown in Table 10.

Table 10: Description of Teacher C

	General opinion	Personal opinion
Mathematics learning	Item 18: - Friends. To teach problems that we don't understand each other. - Ability to listen. It is important to listen in order to understand. - Teacher. Ability to teach is important.	Item 20: - Friends. Friends to teach each other. - Reference book. Explanation is important. - (none)
Mathematics teaching	Item 19: - Colleagues. To share teaching method. - Reference book. The purpose of teaching unit content of mathematics. - (none)	Item 21: - Colleagues. To share teaching method. - Reference book and teaching method to be helpful - (none)

One of the characteristics of the responses of Teacher C is a tendency to value *Wellbeing/Comfort*, since there were many comments on reference book for gathering information on teaching and learning and on the existence of colleagues to consult. There is also a tendency to value *Exposition* since Teacher C mentioned teaching method and ability to listen explanation of others in his responses. And, we also find a tendency to value *Exploration* as one of his characteristics, since there are descriptions on teaching each other.

Therefore, *Wellbeing/Comfort*, *Exposition* and *Exploration* are identified as components of Teacher C's valuing.

(b) Responses from Students of Teacher C

The number and ratio of students in the results of coding for S.Q. items 26-28 are shown in Table 11.

Table 11: Responses from Students of Teacher C (Grade 1: 46 students; Grade 3: 60 students)

	Sub-dimension	Item 26						Item 27						Item 28					
		Grade 1		Grade 3		Total		Grade 1		Grade 3		Total		Grade 1		Grade 3		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	Ability	0	0.0	0	0.0	0	0.0	1	2.2	1	1.7	2	1.9	0	0.0	0	0.0	0	0.0
	Effort	12	26.1	13	21.7	25	23.6	22	47.8	20	33.3	42	39.6	16	34.8	23	38.3	39	36.8
2	Wellbeing /Comfort	12	26.1	18	30.0	30	28.3	17	37.0	28	46.7	45	42.5	3	6.5	4	6.7	7	6.6
	Hardship	0	0.0	1	1.7	1	0.9	0	0.0	0	0.0	0	0.0	3	6.5	1	1.7	4	3.8
3	Process	8	17.4	6	10.0	14	13.2	6	13.0	7	11.7	13	12.3	8	17.4	8	13.3	16	15.1
	Product	11	23.9	14	23.3	25	23.6	10	21.7	6	10.0	16	15.1	4	8.7	9	15.0	13	12.3
4	Application	0	0.0	1	1.7	1	0.9	0	0.0	0	0.0	0	0.0	1	2.2	0	0.0	1	0.9
	Computation	2	4.3	8	13.3	10	9.4	2	4.3	3	5.0	5	4.7	0	0.0	1	1.7	1	0.9
5	Facts/Truths	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Ideas/Practice	1	2.2	0	0.0	1	0.9	2	4.3	0	0.0	2	1.9	1	2.2	1	1.7	2	1.9
6	Exposition	23	50.0	20	33.3	43	40.6	17	37.0	16	26.7	33	31.1	27	58.7	25	41.7	52	49.1
	Exploration	16	34.8	15	25.0	31	29.2	10	21.7	8	13.3	18	17.0	10	21.7	16	26.7	26	24.5
7	Recalling	2	4.3	4	6.7	6	5.7	1	2.2	2	3.3	3	2.8	2	4.3	5	8.3	7	6.6
	Creating	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Firstly, the result of data analysis on the item 26 shows that the sub-dimensions with higher ratio of responses relatively are *Exposition* (40.6%), *Exploration* (29.2%) and *Wellbeing/Comfort* (28.3%). Then, these sub-dimensions are valued by the students of Teacher C as general opinions. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (0.0%), *Hardship* (0.9%), *Application* (0.9%), *Fact/Truths* (0.0%), *Ideas/Practice* (0.9%) and *Creating* (0.0%). Then, these sub-dimensions are not valued by the students of Teacher C as general opinions. In addition, comparing between grades, the sub-dimensions whose ratio of responses decreasing from grade 1 to 3 are *Exposition* (16.7% down).

Secondly, the result of data analysis on the item 27 shows that the sub-dimensions with higher ratio of responses relatively are *Wellbeing/Comfort* (42.5%), *Effort* (39.6%) and *Exposition* (31.1%). Then, these sub-dimensions are valued by the students of Teacher C as personal opinions. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (1.9%), *Hardship* (0.0%), *Application* (0.0%), *Computation* (4.7%), *Fact/Truths* (0.0%), *Ideas/Practice* (1.9%), *Recalling* (2.8%) and *Creating* (0.0%). Then, these sub-dimensions are not valued by the students of Teacher C as personal opinions. In addition, comparing between grades, the sub-dimensions whose ratio of responses decreasing from grade 1 to 3 are *Effort* (14.5% down), *Product* (11.7% down) and *Exposition* (10.3% down).

And, the result of data analysis on the item 28 shows that the sub-dimensions with higher ratio of responses relatively are *Exposition* (49.1%), *Effort* (36.8%) and *Exploration* (24.5%). Then, these sub-dimensions are recognized by the students of Teacher C as what Teacher C values. On the other hand, the sub-dimensions with lower ratio of responses relatively are *Ability* (0.0%), *Hardship* (3.8%), *Application* (0.9%), *Computation* (0.9%), *Fact/Truths* (0.0%), *Ideas/Practice* (1.9%) and *Creating* (0.0%). Then, these sub-dimensions are not recognized by the students of Teacher C as what Teacher C values. In addition, comparing between grades, the sub-dimensions whose ratio of responses decreasing from grade 1 to 3 are *Exposition* (17.0% down).

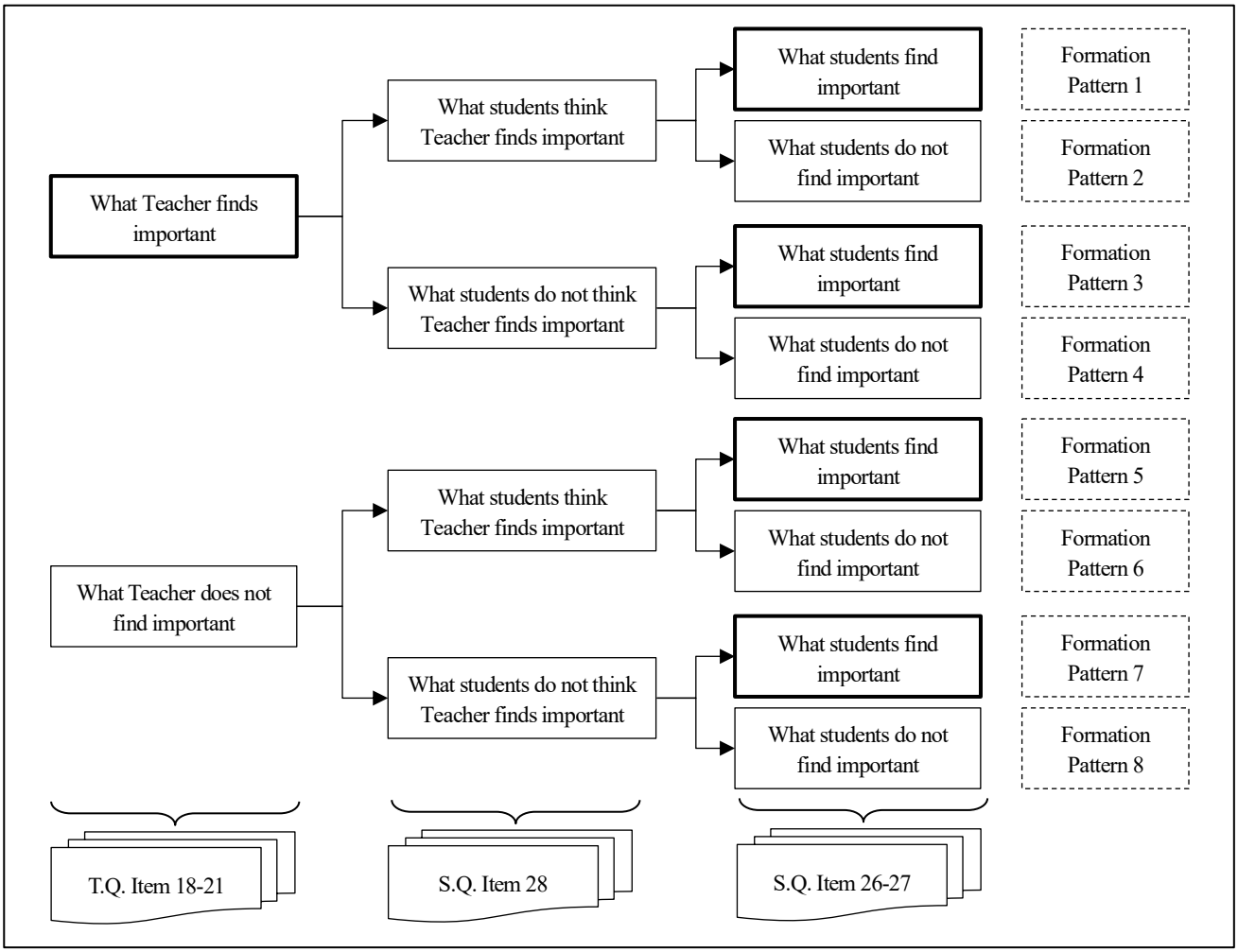

Figure 1: Model on the Formation Process of Students' Valuing in Mathematics Classes (Tentative)

6. Discussion

In discussing the influences of teacher's valuing on the formation of students' valuing, we first set up a "Model on the formation process of students' valuing in mathematics class" (Figure 1), which considers the connections among "what teacher finds important (teacher's valuing)", "what students think their teacher finds important (students' recognition)" and "what students find important (students' valuing)" as the formation process of students' valuing.

In the following discussion, we identify "what teacher finds important" by examining the characteristics of the responses to T.Q. items 18-21. We identify "what students think their teacher finds important" and "what students find important" by examining the response ratios of S.Q. item 28 and S.Q. items 26 and 27 respectively. Then, we discuss the formation processes of students' valuing in each group considering which of the eight formation patterns each of the sub-dimensions of mathematical educational values is located. By the way, Teacher B and C have classes in multiple grades, and we comfirmed a difference of about 30% in the response ratios between the grades (Teacher B's students' response ratio on S.Q. item 28: *Effort*), and a difference of about 20% in the response ratios between the grades (Teacher B's students' response ratio on S.Q. item 28: *Wellbeing/Comfort* and *Computation*). However, we judge here that there is not much difference overall, and discuss seeing the students in multiple grades of Teacher B and C as a group respectively.

(1) Relationship of Valuing between Teacher A and Their Students

First of all, the sub-dimensions *Effort*, *Wellbeing/Comfort*, *Process*, *Product*, *Computation*, *Exposition* and *Exploration* were identified as the components of Teacher A's valuing from her responses to the teacher questionnaire. On the other hand, the sub-dimensions *Ability*, *Hardship*, *Application*, *Facts/Truths*, *Ideas/Practice*, *Recalling* and *Creating* were not identified from her responses as what she finds important. Then, we arranged the response ratios of Teacher A's students as Figure 2 in

the order of "what students think their teacher finds important" (S.Q. Item 28), "what students find important as general opinion" (S.Q. Item 26) and "what students find important as personal opinion" (S.Q. Item 27) according to what Teacher A finds important and what she doesn't.

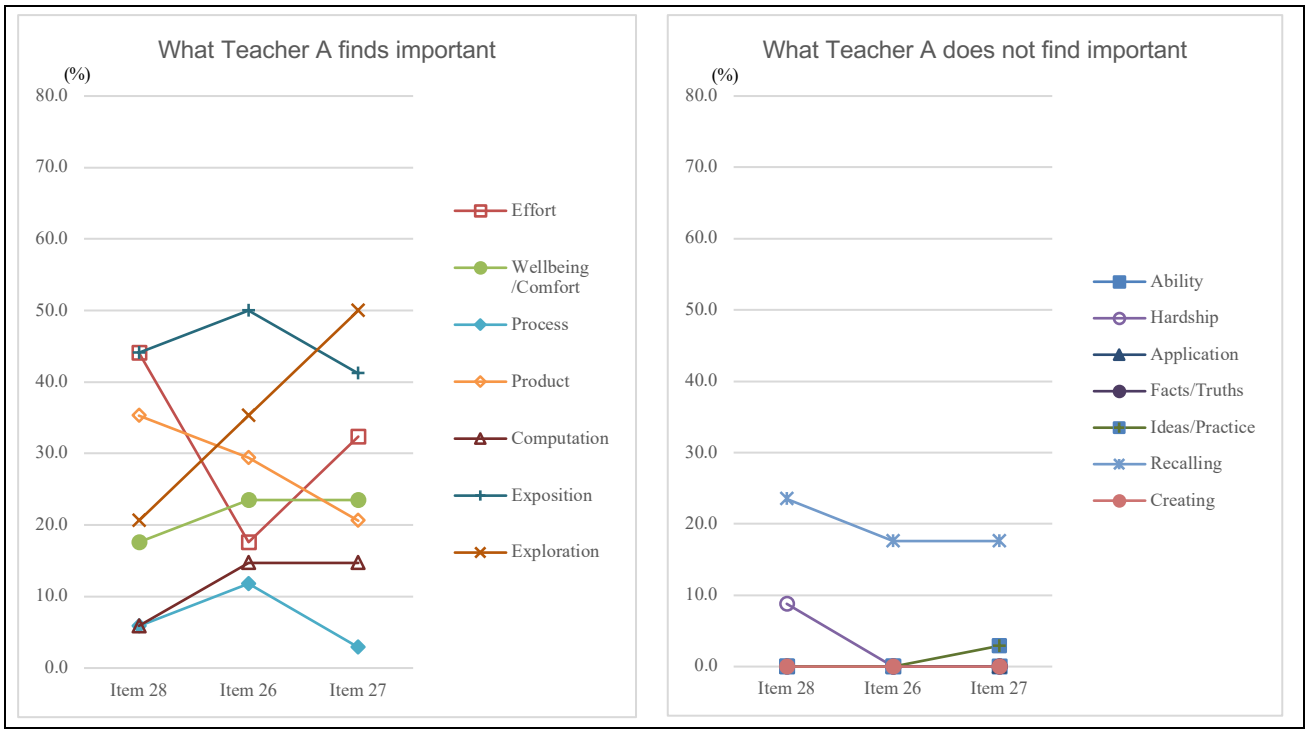

Figure 2: Formation Process of Students' Valuing in Teacher A's Mathematics Classes

Firstly, looking at the sub-dimensions that Teacher A finds important, *Exploration*, *Exposition* and *Effort* are the sub-dimensions with higher ratio of responses to S.Q. item 27, and *Process* is with lower ratio of responses to S.Q. item 27. In the sub-dimensions with higher ratio of responses to S.Q. item 27, *Exposition* and *Effort* are also the sub-dimensions with higher ratio of responses to S.Q. item 28 (both 44.1%), and *Exploration* is the sub-dimension with slightly lower ratio of responses to S.Q. item 28 at 20.6%. That means, *Exposition* and *Effort* are what Teacher A finds important, her students also recognize that, and the students themselves find those sub-dimensions important. On the other hand, *Exploration* is what Teacher A finds important, though her students don't recognize that, but the students themselves find the sub-dimension important. With regard to the sub-dimension *Process* with lower ratio of responses to S.Q. item 27, since the ratio of responses to S.Q. item 28 is also low at 5.9%, it is possible to say that Teacher A finds the sub-dimension important, but her students don't recognize that, and the students themselves don't find it important.

Secondly, looking at the sub-dimensions that Teacher A does not find important, there is no sub-dimension with higher ratio of responses to S.Q. item 27, and *Ability*, *Hardship*, *Process*, *Application*, *Facts/Truths*, *Ideas/Practice* and *Creating* are the sub-dimensions with lower ratio of responses to S.Q. item 27. The response ratios to S.Q. item 28 regarding those sub-dimensions are as low as 0.0%, 8.8%, 5.9%, 0.0%, 0.0%, 0.0%, and 0.0%, respectively. It means, it is possible to say that Teacher A does not find those sub-dimensions important, her students don't think that their teacher finds them important, and the students themselves don't find them important.

Based on the above, Table 12 summarises the pattern of the formation process of the student's valuing in the mathematics class of Teacher A.

Table 12: Formation Patterns of Students' Valuing in Teacher A's Mathematics Classes

Formation Pattern	Sub-dimension
Pattern 1	Effort; Exposition
Pattern 2	-
Pattern 3	Exploration
Pattern 4	Process
Pattern 5	-
Pattern 6	-
Pattern 7	-
Pattern 8	Ability; Hardship; Application; Fact/Truths; Idea/Practice; Creating

Therefore, in the mathematics class of Teacher A, *Exposition* and *Effort* are valued by the teacher, and her students recognize that, and those sub-dimensions are accepted as components of the students' valuing. With regard to *Exploration* that Teacher A values, though her students do not recognize such valuing of Teacher A, but they accept the sub-dimension as a component of their own valuing. On the other hand, with regard to *Process* that Teacher A values, her students do not recognize such valuing of Teacher A, and they do not accept the sub-dimension as a component of their own valuing too. In addition, with regard to *Ability*, *Hardship*, *Application*, *Facts/Truths*, *Ideas/Practice* and *Creating*, it is possible to say that Teacher A and her students do not value those sub-dimensions.

(2) Relationship of Valuing between Teacher B and his Students

Next, in the case of Teacher B, the sub-dimensions *Effort*, *Wellbeing/Comfort*, *Process*, *Product*, *Application* and *Exposition* were identified as the components of Teacher B's valuing from his responses to the teacher questionnaire. On the other hand, the sub-dimensions *Ability*, *Hardship*, *Computation*, *Facts/Truths*, *Ideas/Practice*, *Exploration*, *Recalling* and *Creating* were not identified from his responses as what he finds important. Then, we also arranged the response ratios of Teacher B's students as Figure 3 according to what Teacher B finds important and what he doesn't as well as the case of Teacher A.

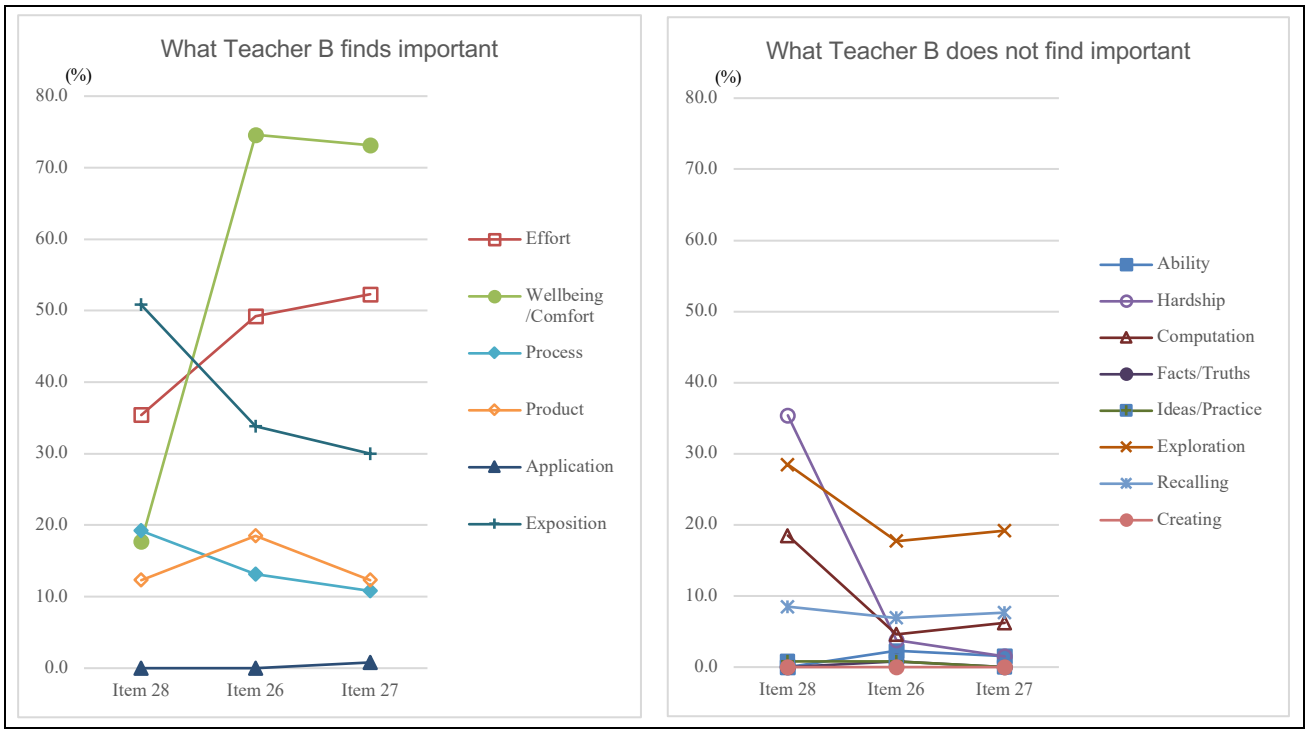

Figure 3: Formation Process of Students' Valuing in Teacher B's Mathematics Classes

Firstly, looking at the sub-dimensions that Teacher B finds important, *Wellbeing/Comfort*, *Effort* and *Exposition* are the sub-dimensions with higher ratio of responses to S.Q. item 27, and *Application* is with lower ratio of responses to S.Q. item 27. In the sub-dimensions with higher ratio of responses to S.Q. item 27, *Effort* and *Exposition* are also the sub-dimensions with relatively higher ratio of responses to S.Q. item 28 (35.4%, 50.8%, respectively), and *Wellbeing/Comfort* is the sub-dimension with slightly lower ratio of responses to S.Q. item 28 at 17.7%. That means, *Effort* and *Exposition* are what Teacher B finds important, his students also recognize that, and the students themselves find those sub-dimensions important. On the other hand, *Wellbeing/Comfort* is what Teacher B finds important, though his students don't recognize that, but the students themselves find the sub-dimension important. With regard to the sub-dimension *Application* with lower ratio of responses to S.Q. item 27, since the ratio of responses to S.Q. item 28 is also low at 0.0%, it is possible to say that Teacher B finds the sub-dimension important, but his students don't recognize that, and the students themselves don't find it important.

Secondly, looking at the sub-dimensions that Teacher B does not find important, there is no sub-dimension with higher ratio of responses to S.Q. item 27, and *Ability*, *Hardship*, *Facts/Truths*, *Ideas/Practice* and *Creating* are the sub-dimensions

with lower ratio of responses to S.Q. item 27. In addition, the response ratios to S.Q. item 28 regarding *Ability*, *Facts/Truths*, *Ideas/Practice* and *Creating* are as low as 0.0%, 0.0%, 0.8% and 0.0% respectively (except *Hardship* at 35.4%). It means, it is possible to say that Teacher B does not find those sub-dimensions important except *Hardship*, his students do not think that their teacher finds them important, and the students themselves don't find them important. However, with regard to the sub-dimension *Hardship*, though Teacher B does not find it important, his students think that their teacher finds it important, but they themselve do not find it important.

Based on the above, when we organize the pattern of the formation process of the student's valuing in the mathematics class of Teacher B, it becomes as shown in Table 13.

Therefore, in the mathematics class of Teacher B, *Effort* and *Exposition* are valued by the teacher, and his students recognize that, and those sub-dimensions are accepted as components of the students' valuing. With regard to *Wellbeing/Comfort* that Teacher B values, though his students do not recognize such valuing of Teacher B, but they accept the sub-dimension as a component of their own valuing. On the other hand, with regard to *Application* that Teacher B values, his students do not recognize such valuing of Teacher B, and they do not accept the sub-dimension as a component of their own valuing too. In addition, with regard to *Ability*, *Hardship*, *Facts/Truths*, *Ideas/Practice* and *Creating*, it is possible to say that Teacher B and his students do not value those sub-dimensions.

Table 13: Formation Patterns of Students' Valuing in Teacher B's Mathematics Classes

Formation Pattern	Sub-dimension
Pattern 1	Effort; Exposition
Pattern 2	-
Pattern 3	Wellbeing/Comfort
Pattern 4	Application
Pattern 5	-
Pattern 6	-
Pattern 7	-
Pattern 8	Ability; Hardship; Fact/Truths; Idea/Practice; Creating

(3) Relationship of Valuing between Teacher C and Their Students

At last, in the case of Teacher C, the sub-dimensions *Wellbeing/Comfort*, *Exposition* and *Exploration* were identified as the components of Teacher C's valuing from his responses to the teacher questionnaire. On the other hand, the sub-dimensions *Ability*, *Effort*, *Hardship*, *Process*, *Product*, *Application*, *Computation*, *Facts/Truths*, *Ideas/Practice*, *Recalling* and *Creating* were not identified from his responses as what he finds important. Then, we arranged the response ratios of Teacher C's students as Figure 4 according to what Teacher C finds important and what he doesn't.

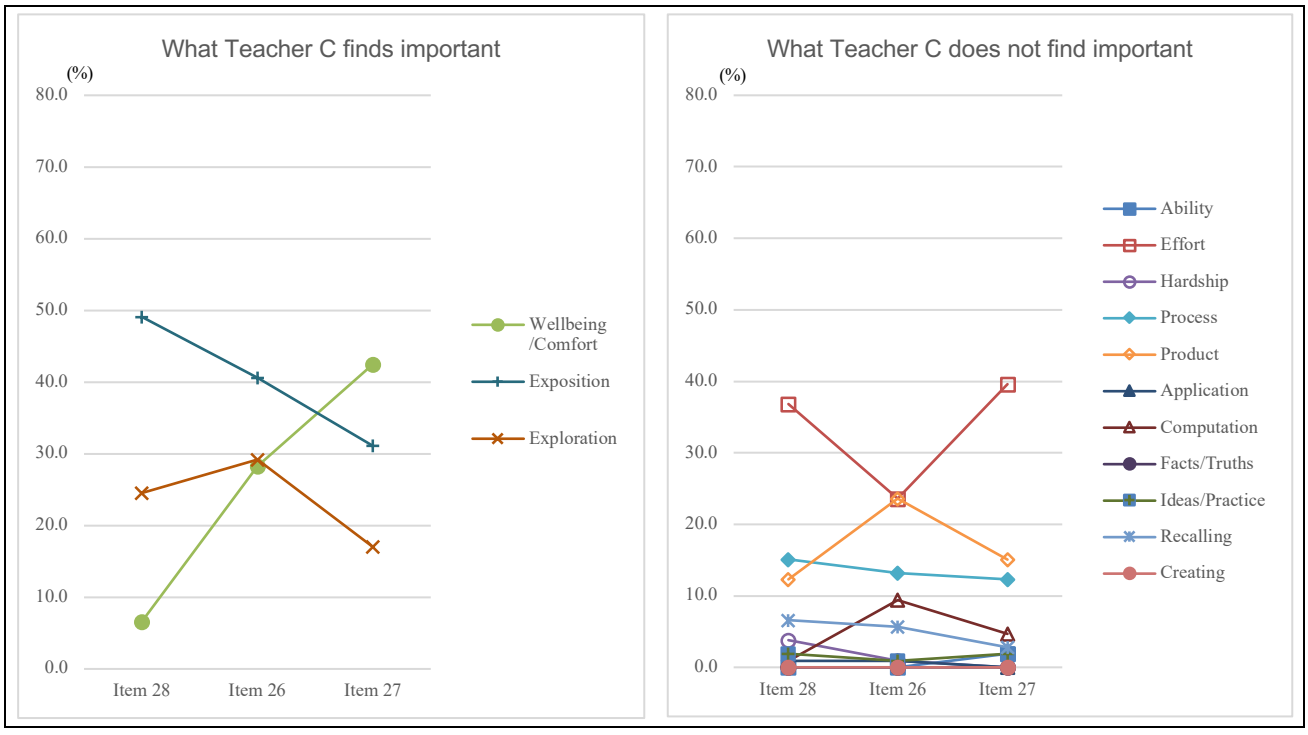

Figure 4: Formation Process of Students' Valuing in Teacher C's Mathematics Classes

Firstly, looking at the sub-dimensions that Teacher C finds important, *Wellbeing/Comfort* and *Exposition* are the sub-dimensions with higher ratio of responses to S.Q. item 27. In the sub-dimensions with higher ratio of responses to S.Q. item 27, *Exposition* is also the sub-dimensions with higher ratio of responses to S.Q. item 28 (49.1%), but *Wellbeing/Comfort* is with lower ratio of responses to S.Q. item 28 at 6.6%. That means, *Exposition* is what Teacher C finds important, his students also recognize that, and the students themselves find those sub-dimensions important. On the other hand, *Wellbeing/Comfort* is what Teacher C finds important, though his students don't recognize that, but the students themselves find it important.

Secondly, looking at the sub-dimension that Teacher C does not find important, *Effort* is the sub-dimensions with higher ratio of responses to S.Q. item 27, and is also with higher ratio of responses to S.Q. item 28 at 36.8%. It means, it is possible to say that though Teacher C does not find *Effort* important, his students think that their teacher finds it important, and the students themselves find it important. On the other hand, *Ability*, *Hardship*, *Application*, *Computation*, *Facts/Truths*, *Ideas/Practice*, *Recalling* and *Creating* are the sub-dimensions with lower ratio of responses to S.Q. item 27, and also with lower ratios of the response to S.Q. item 28 at 0.0%, 3.8%, 0.9%, 0.9%, 0.0%, 1.9%, 6.6% and 0.0% respectively. It means, it is possible to say that Teacher C does not find those sub-dimensions important, his students do not think that their teacher finds them important, and the students themselves do not find them important.

Based on the above, our organisation of the pattern of the formation process of the student's valuing in the mathematics class of Teacher C allows us to present Table 14.

Therefore, in the mathematics class of Teacher C, *Exposition* is valued by the teacher, and his students recognize that, and the sub-dimension is accepted as a component of the students' valuing. With regard to *Wellbeing/Comfort* that Teacher C values, though his students do not recognize such valuing of Teacher C, but they accept the sub-dimension as a component of their own valuing. On the other hand, with regard to *Effort*, though Teacher C does not value, his students recognize that their teacher values it and accept the sub-dimension as a component of their own valuing. In addition, with regard to *Ability*, *Hardship*, *Application*, *Computation*, *Facts/Truths*, *Ideas/Practice*, *Recalling* and *Creating*, it is possible to say that Teacher C and his students do not value those sub-dimensions.

Table 14: Formation Patterns of Students' Valuing in Teacher C's Mathematics Classes

Formation Pattern	Sub-dimension
Pattern 1	Exposition
Pattern 2	-
Pattern 3	Wellbeing/Comfort
Pattern 4	-
Pattern 5	Effort
Pattern 6	-
Pattern 7	-
Pattern 8	Ability; Hardship; Application; Computation; Fact/Truths; Idea/Practice; Creating

(4) Overall Discussion

Based on the above discussions, we consider the pattern of the formation process of mathematics educational valuing and the sub-dimensions of mathematics educational valuing.

(a) Formation Process Perttarn of Mathematics Educational Valuing

Through these three cases, we were able to confirm Patterns 1, 3, 4, 5 and 8 out of the patterns of the formation process of mathematics educational valuing shown in Figure 1. This suggests that these five patterns are more appropriate in these three cases as the patterns of the formation process of valuing

Among them, Patterns 1, 3 and 5 are the ones in which students' valuing are formed.

Pattern 1 is a process in which students recognize that their teacher values a thing, and the students themselves also value same thing. It can be said that it is a pattern in which a teacher's valuing directly influence to the formation of their students' valuing.

Pattern 5 is a process in which students recognize that their teacher values a thing although the teacher does not value, and the students themselves value the thing. It can be said that it is a pattern in which a teacher's valuing do not directly influence to the formation of their students' valuing. In this process, there is a gap between teacher's valuing and their students' recognition on the teacher' valuing, and there is a possibility that students have different valuing from their teacher's ones. The factors that cause this formation process might be the influence of teacher's valuing that are unconsciously emerged and the valuing shared in classes, school, and communities.

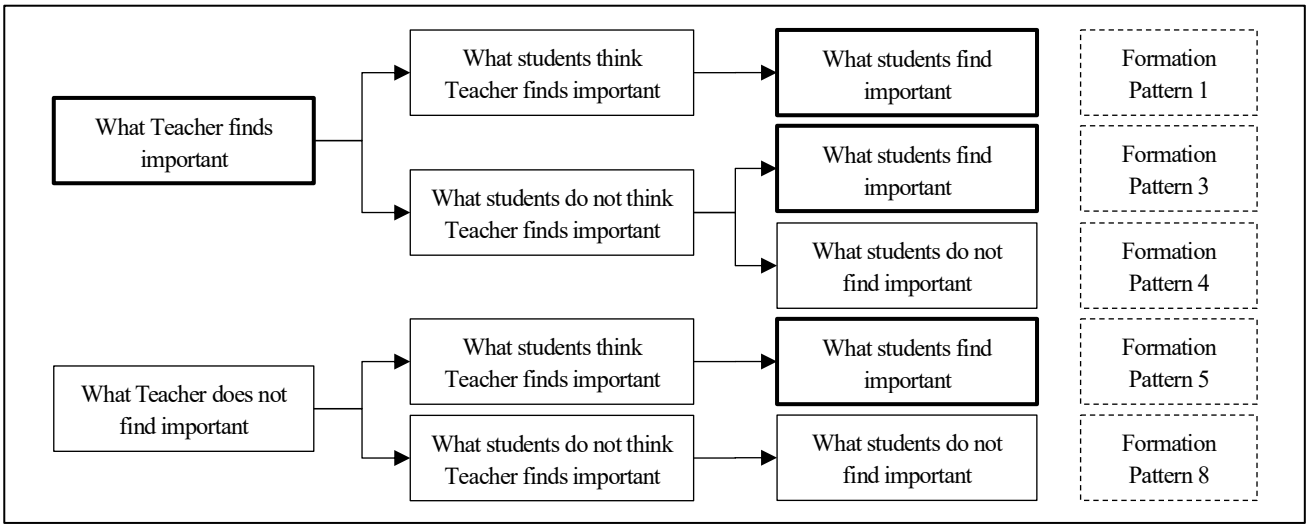

Figure 5: Model on the Formation Process of Students' Valuing in Mathematics Classes

Pattern 3 is a process in which students do not recognize what their teacher values, but students also value same thing that their teacher values. It can be said that it is a pattern in which a teacher's valuing do not directly influence to the formation of their students' valuing, as well as Pattern 5. In this process, teacher and students have same valuing, even though there are two gaps between teacher's valuing and students' recognition on the teacher' valuing, and between the students' recognition and their valuing. The factors that cause this formation process might be that although students cannot recognize their teacher's valuing because the teacher is unable to or intentionally do not communicate his/her own valuing, the students acquire same valuing as their teacher's ones by the influence of valuing shared in classes, schools, and communities or their own mathematics learning experiences. Rather than personal matters of teacher and students, it may be seen as a pattern influenced by social and cultural context that they share.

On the other hand, there are patterns in which students' valuing are not formed. Those are Pattern 4 and 8.

Pattern 8 is a process in which students recognize that their teacher does not value a thing, and the students do not value it too. Paradoxically, it is a pattern in which teacher's valuing directly influence the formation of students' valuing, which means that valuing that teacher does not have are not formed by his/her students.

Pattern 4 is a process in which students do not recognize that their teacher values a thing, and therefore, students do not value the thing. It can be said that it is a pattern in which a teacher's valuing do not directly influence to the formation of their students' valuing. In this process, there is a gap between teacher's valuing and student's recognition on their teacher's valuing, and this can be regarded as an obstacle to the formation of students' valuing.

(b) Sub-Dimensions of Mathematics Educational Valuing

Next, with regard to the sub-dimensions of mathematical educational valuing examined in these three cases, *Exposition* was confirmed in all cases as being handed over from teachers to students. On the other hand, there were the sub-dimensions *Ability*, *Hardship*, *Facts/Truths*, *Ideas/Practice* and *Creating* as those that both teachers and students do not value.

Of course, the questionnaire survey adopted in this paper has its limitations as a method of grasping the valuing of teacher and students. For instance, valuing that could not be described in the questionnaire even if theacher and students had due to the limitation of the number of responses, or valuing that are unconsciously emerged but not expressed in their descriptions cannot be grasped in this survey, so that it has not been able to grasp all aspects of the valuing that the respondents have. However, some aspects of their valuing captured in this survey can be regarded as being strongly conscious by respondents. In that respect, the sub-dimensions *Ability*, *Hardship*, *Facts/Truths*, *Ideas/Practice* and *Creating* can be regarded as relatively unconscious. It can be said that it is an issue in future mathematics education which aims at the development of students' quality and ability to think mathematically through mathematical activity with using mathematical view and idea that teacher and students become more conscious of such sub-dimensions. In particular, it is more important to consider how students can form valuing such as *Facts/Truths*, *Ideas/Practice* and *Creating*.

7. Conclusion

In this paper, we analysed a part of the collected data of the questionnaire survey in Miyazaki prefecture, Japan, and discussed the characteristics of the interaction between students' and teachers' valuing.

As the result of examining the cases of three teachers and their students, an aspect of the characteristics of the relationship between the valuing of each teacher and his/her students and the process of forming students' valuing in each case of mathematics classes were clarified. In addition, it was clarified as common characteristics in the three cases that *Exposition* is handed over from teacher to student but *Ability*, *Hardship*, *Facts/Truths*, *Ideas/Practice* and *Creating* are not valued by teachers and their students, and that the formation patterns 1, 3, 4, 5 and 8 seem to be appropriate as patterns of the formation process of students' valuing.

However, since the number of participants in the survey is small, it may be premature to generalize the conclusions derived from the three cases as characteristics of Miyazaki Prefecture. We would like to consider the conclusion of this paper as a topic for further investigation, by positioning the survey as a preliminary survey, increasing the number of target participants, analyzing data including examples of other research areas, and analyzing the responses of other items in the questionnaire WIFItoo.

In this paper, the analysis did not extend to the formation process of individual student's valuing, though the process of forming valuing of students as groups was examined. And, since the social interaction between teachers and students in actual mathematics classes has not been considered, it is not enough to grasp the facts of the formation process of students' valuing. This point should be tackled as the second research question of this study through lesson analysis and interview with teachers and students.

In addition, it is necessary to consider the model of the formation process of students' valuing in mathematics class proposed in this paper, the conceptual framework of valuing in mathematics education, and the ways of qualitative coding for the WIFItoo questionnaire as issues of research methods. Although this discussion focused on the influence of teacher's valuing, there is room for consideration of valuing that students form independently and their formation processes.

Finally, it will be necessary also to consider how to form students' valuing such as *Facts/Truths*, *Ideas/Practice* and *Creating* that were not conscious of both teachers and students in the cases of this paper and that will be emphasized in future mathematics education in Japan,

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