Ontological descriptions of receiver states for sharing knowledge in learning service design


* Graduate School of Science and Engineering, Saitama University
255 Shimo-Okubo, Sakura-ku, Saitama City, Saitama 338-8570, Japan
E-mail: muramatsu@mech.saitama-u.ac.jp

** Department of System Design, Tokyo Metropolitan University
6-6 Asahigaoka, Hino City, Tokyo 191-0065, Japan

*** Faculty of Human Sciences, Waseda University
2-579-15 Mikajima, Tokorozawa City, Saitama 359-1164, Japan

Received: 15 December 2015; Revised: 20 April 2016; Accepted: 19 February 2017

Abstract
Recently, the viewpoint of service has become widespread. In learning domains, service providers have been required to adopt the viewpoint and to provide values co-created by teachers and learners. However, production by a service provider means the generation of potential value, whereas usage by a service receiver implies the generation of real value. That is, a receiver creates value independent of the value generated by a provider. Indeed, value co-creation takes place in a joint sphere where providers and customers interact with each other. Thus, service providers must attempt to generate the potential value through service design and play a role of co-producer of the real value in the interactions between the providers and the receivers. In the current study, we developed an ontology to share the knowledge on value co-creation and the information related to the interactions between the providers and the receivers. In concrete terms, we proposed ontological descriptions of receiver states for sharing knowledge in learning service design, and conceptualized elements of consensus building and value co-creation, according to the conceptual model of value co-creation proposed in a previous study. In addition, concepts pertaining to academic emotions are also described to represent contents of consensus building. Then, we demonstrated instances of a consensus building, which is extracted from conversations during counseling by a teacher (mentor) and a learner. As a result, we obtained a metamodel for co-design processes in the learning service design, and a conceptual framework of the knowledge sharing on learning states including academic emotions by the ontological descriptions.

Key words: Ontology, Receiver states, Learning service design, Consensus building, Mental states

1. Introduction

In the last decade, the concept of value co-creation has become widespread. For example, service-dominant logic (Vargo and Lusch, 2004) and service logic (Grönroos, 2006) have received considerable attention in the field of marketing. These studies discussed value creation by consumers in the usage process. Although the concept of value is difficult to define and measure, Grönroos (2008) used the following simple working definition: “Value for customers means that after they have been assisted by a self-service process (cooking a meal or withdrawing cash from an ATM) or a full-service process (eating out at a restaurant or withdrawing cash over the counter in a bank), they are or feel better off than before.” That is, value emerges through the physical or mental use of resources. Therefore, value is realized through possession, usage, or mental states (Grönroos and Ravald, 2011).

On the other hand, in the field of service engineering, Shimomura et al. (2003) defined a service as an activity by a service provider to change the state of a service receiver, and proposed receiver state parameters (RSPs) to represent the receivers’ state in a service process. This literature also seems to model value creation as a matter of process. However,
production including design is the generation of potential value, whereas usage is the generation of real value (Grönroos, 2011). Hence, the scopes of service marketing and engineering are different. According to Grönroos and Voima (2013), value co-creation takes place in a joint sphere where providers and customers interact with each other. In line with service engineering, how a provider generates the potential value and the interaction between providers and receivers are important. However, thus far, an appropriate design method has not been established in the fields of service engineering and marketing, whereas a conceptual model of value co-creation (Nemoto et al., 2014) and a representation of the receivers’ state (e.g., RSPs) mentioned above have been proposed. One of the reasons for this seems to be the lack of a conceptual framework shared by researchers in these fields.

In the product development, a model-based approach has been proposed and applied to a broad range of design knowledge. One adopted matrix representation to capture relationships among design tasks to be performed (Eppinger et al., 1994). Others used directed or undirected graph representation to describe design knowledge. A model of knowledge template (Koga et al., 2009) is a kind of directed graph representation, which expresses knowledge pertaining to the product structure, hierarchy, function, and design process. Furthermore, methods focusing on formalizing specifications, attributes, and relations that are extracted from product models, such as mathematical formulae, simulation models, and evaluation models, have been described using undirected graph representations (Komoto et al., 2016). This research aimed to systematize knowledge on product design and to process the knowledge as a computational application. Adequate results have been achieved, because their target domains pertain to products as distinct from services. However, when it comes to services focusing on value co-creation, valid models and representations have not yet been established.

One of the reasons why describing and systematizing services are less than successful is the complexity resulting from the involvement of multiple disciplines. For example, generally a teacher who designs and conducts classes is regarded as a service provider, and a student who attends the classes is regarded as a service receiver, in the face of a traditional perspective. Teachers are not service engineering experts but educational experts. Furthermore, teacher and student are a kind of co-designer of classes and the whole educational service, from the viewpoint of value co-creation. Obviously, students are not experts of both education and service engineering. Sanders and Stappers (2008) took the term co-creation to refer to “any act of collective creativity, i.e. creativity that is shared by two or more people,” and took the term co-design to refer to the “collective creativity as it is applied across the whole span of a design process.” That is, co-design is a specific instance of co-creation, and a key to achieving value co-creation in specific target domains. Therefore, a model-based approach to the development of educational services is not easier than ordinary product development.

The complexity that results from multi-discipline development can be classified into three types of difficulty: (i) there is no common inter-disciplinary design language (an ontology problem); (ii) there are inherent difficulties in dealing with many stakeholders during the design process; and (iii) multi-disciplinary product development creates inter-disciplinary problems (Tomiyama et al., 2007). The researchers in the field of service engineering, marketing, and educational engineering are analyzing and modeling the activities of stakeholders involved in a specific service. In other words, how value is co-created by the stakeholders has yet to be elucidated fully, and they are now collecting and exploring various case examples. Because this research is still in a pioneering stage, researchers and stakeholders need common language to understand and design target services. Hence, the resolution of the first type of difficulty is essential in this research stage.

The current study attempts to develop an ontology to share the knowledge on value co-creation and the interaction between providers and receivers, in the field of learning services. In concrete terms, we develop ontological descriptions for receiver states and try to specialize the concepts to demonstrate the descriptions in the domain of learning service design, with a conceptualization of the contents agreed upon by a teacher (mentor) and a learner based on a conceptual model of value co-creation. More detailed requirements of the ontology to be developed are described in Section 2, by introducing models of value co-creation and academic emotions.

2. Value co-creation and academic emotions
2.1 Mental states in learning services

Figure 1 shows the conceptual model of value co-creation mentioned in the introduction. A service is provided by means of contents and channels. In this service process, value co-creation takes place as a result of certain actions and
perceptions of the provider and the perceiver. When the value co-creation emerges, the provider and the perceiver change their mental states, by using their own knowledge and skill, which are often called competency or literacy. The mental states include the perceived actual state and the ideal states of the provider, receiver, and contents/channel. The actual and ideal states can be called the ASIS and TOBE states. The key factor for the emergence of value co-creation seems to be reaching a consensus on the ideal states of the provider, receiver, and contents/channel between the provider and the receiver. In line with this model, service design requires representations and their conceptual framework for reaching a consensus between the provider and the receiver and for value co-creation. The representation and conceptual framework indicate a kind of metamodel against the model of value co-creation shown in Fig. 1. The ontology we intend to construct in the current study plays the role of a metamodel, because the ontology provides taxonomy and axioms that specify knowledge models. Taxonomy is a hierarchical system of concepts, and axioms are rules, principles, or constraints among the concepts. An ontology has three levels of layer; lexical level, conceptual level, and symbol level (Ikeda et al., 1997). According to the literature, the lexical level concerns the syntactic aspect of descriptions, and the symbolic level corresponds to runnable programs with a specification of the computational semantics. On the other hand, the conceptual-level ontology is an ontology that represents the content of knowledge in their minds. That is, it specifies the meaning of each concept and the relationships between concepts. In the current study, we meet the demand for the conceptual level ontology to be developed.

2.2 Emotions in academic settings

In the field of learning services, the imagined states related to academic activities and outcomes (e.g., tests, exercises, and the results of these activities) are the mental states. Learners’ emotions related to such academic activities and outcomes are also regarded as a kind of mental state, e.g., boredom for a test, anxiety for the result of a test expected in a few days, and pride for a good score on a test are some possible mental states. These kinds of learners’ emotions related to academic learning, classroom instruction, and achievement are referred to as academic emotions (Pekrun et al., 2002). The emotions related to the achievement are specified as achievement emotions and measured using an academic emotion questionnaire (Pekrun et al., 2011). This questionnaire consists of question items corresponding to nine emotions: enjoyment, boredom, anger, hope, anxiety, hopelessness, pride, relief, and shame. These nine emotions are classified into two types of emotions according to their object focus: activity emotions that pertain to ongoing achievement-related activities; and outcome emotions that pertain to the outcome of these activities. The object focus indicates the target of an emotional appraisal. Enjoyment, boredom, and anger are included in the set of activity emotions. Moreover, the outcome emotions include prospective outcome emotions such as hope, anxiety, and hopelessness, as well as retrospective outcome emotions such as pride, relief, and shame.

Academic emotions are conceptually explained based on the control-value theory, which was proposed by Pekrun (2006). This theory states that two types of appraisals are of primary importance. One is the appraisal of subjective control, and the other is the appraisal of value. The former pertains to the perceived controllability of actions and
outcomes related to achievement, and the latter pertains to the subjective importance related to the achievement. In the case of activity emotions, control and values refer to the actions rather than the outcomes. The prospective outcome emotions are identified by whether there is a lack of control in the attainment of success (positive value) or the avoidance of failure (negative value). In contrast, retrospective outcome emotions are induced when success (positive value) and failure (negative value) are perceived to be caused by internal factors. That is, the control concerns whether the outcome was caused by the self or by other persons and/or external circumstances.

As mentioned in the introduction, since value means that service receivers are or feel better off than before, their perceived mental states including emotions, can be a value co-created in an interaction between service provider and receiver. However, what value is for learners and how it emerges in a learning service are less obvious in this research stage. Therefore, the current study excludes real value co-created from the scope of ontology, and covers only potential value, which is inferable according to receivers’ words and actions.

3. Method for ontology development
3.1 Ontology representation

Ontology engineering is one of the methodologies used for describing knowledge systematically on the basis of concept definitions. From a knowledge-based viewpoint, “ontology is defined as a theory (system) of concepts/vocabulary used as the building blocks of an information processing system” (Mizoguchi et al., 1995). In the ontology development environment Hozo (http://www.hozo.jp/), each node represents a whole concept and has some slots that represent the part-of or attribute-of relations (Fig. 2). In the left half of Fig. 2, the node labeled “context” represents a whole concept. Each whole concept consists of one or more part-concepts with part-of or attribute-of slots. The slots linked to the whole concept represent part-of and attribute-of relations. The “class constraint” in these slots referred to another whole concept. Therefore, the slots represent links between concepts. Hozo helps to describe role concepts wherein a role depends on the contents of each whole concept. For example, a teacher’s role is played only in the context of a school. Thus, every slot has a role within a whole concept that implies a context. In the context, a class of instances that can play a role is defined by a class constraint and is called as a role-holder (Kozaki et al., 2000). Thus, the role concept distinguishes between concepts within different contexts. Inherited role holders and class constraints imported from other ontologies are represented as shown in the right half of Fig. 2.

Fig. 2 Representation of nodes and links in the ontology development environment Hozo.

3.2 Top-level ontology

Mizoguchi (2010) constructed a top-level ontology based on the role concept theory known as “yet another more advanced top-level ontology (YAMATO).” YAMATO’s main features are the definitions of qualities and quantities, their representations, and descriptions of their interrelationships in other top-level ontologies. The attributes of entities are represented as qualities that are composed of quality values. A quality value belongs to a “categorical” class, and a quantity contains a quantitative quantity and a qualitative quantity. A quality is divided into a property and a generic quality, with the property being an abstraction of the generic quality but possessing a quality value. The generic quality is divided into “intrinsic generic quality” and “accidental generic quality.” A subclass of the intrinsic generic quality is the basic generic quality, which contains “quantitative generic quality” and “qualitative generic quality.”

In YAMATO, the representation of a quality is distinguished from a real quality that exists with an entity. Therefore, representations of qualities and quantities are defined as transformations of a real quality through an “action to measure.” The corresponding measure contains a part-of slot that indicates a “result” role played by a primitive representation. A quality measurement is defined as a role holder played by a proposition in a content role subslot of the result role slot. Through measurements, we find that the data are approximations of real qualities and that a quality...
value representing a true value is independent of any measurements. Therefore, representations of a quality that a priori exists must be distinct from representations of a quality obtained through measurements (Masuya et al., 2011).

3.3 Attributes describing mental states

Muramatsu et al. (2011, 2015) partially expanded YAMATO to describe a subjective evaluation that is regarded as an expression of a psychological quantity. More precisely, it is defined as a representation of quality (defined in YAMATO) based on a doer’s awareness. A doer’s awareness is described as a state of “being aware” (Fig. 3), which is defined as a subclass of an “external state” in YAMATO. The upper texts of a slot that represent the part-of or attribute-of relations provide role name and information about its upper slot. Concretely, the right side of symbols “<<” indicates the upper concept and slot that the lower concept inherits a definition from. The symbol “S” sets off names of the concept and the slot, and the symbol “%” sets off names of concept and its slot as well. The objects of awareness are represented by “of-what” role holders played by a “physical” or a “semi-abstract.” A subslot of of-what is played by the “quality on awareness,” which represents a psychological quality that a doer feels. The action focused on awareness is defined as a subclass of the actor state action in YAMATO and is composed of the slots of doer, object, and result. Since the doer’s awareness can be observed only when it is expressed explicitly, the content of awareness is defined as a role holder of a content role under the result slot. The object of awareness, which is a role holder in the object slot, is linked to the content of awareness by a “depend on” link.

Fig. 3 State of being aware (upper) and awareness-focused actions (lower).

Qualities that exist on awareness and their values are sharply distinguished from the physical qualities and their values defined in YAMATO. Figure 4 shows the hierarchy of “quality on awareness” and “quality value on awareness.” The symbol “W” at the beginning of a concept name indicates that the concept is a whole concept as distinct from a relation concept. Learners’ psychological qualities such as conviction and hesitance are defined as a subclass of “cognitive quality” under the quality on awareness. For example, “conviction” has two “referring to” slots: one is “conviction quantity” and the other is “conviction value.” The conviction quality is a subclass of “quantitative cognitive quality value,” and the conviction value is a subclass of the “qualitative cognitive quality value.” Both quantitative and qualitative cognitive quality values are defined under “quality value on awareness.”

Fig. 4 Hierarchy of quality and quality value on awareness.
4. Ontological descriptions of receiver states

To describe receiver states including academic emotions, we developed ontological descriptions. We used the ontology development environment Hozo and referred to the OMNIBUS ontology (Hayashi et al., 2009a, 2009b) as an upper ontology. The OMNIBUS is an ontology organizing learning and instructional theory and has a similar structure of concepts in the upper levels to that of the top-level ontology YAMATO. Thus, the existing concepts of subjective attributes mentioned in the previous section are adequately structured in the OMNIBUS. Our proposal contains three kinds of ontological description: (i) concepts related to consensus building and specializations in the service design domain; (ii) concepts related to consensus primitives to be shared by teacher and students; (iii) concepts related to quality and quality value of academic emotions.

First, Fig. 5 shows the concept related to consensus building. The “consensus-building” and “value co-creation” are described under a node named as “World of value co-creation” which indicates a target world. This world is separated from other worlds defined in OMNIBUS such as Common world, Learning world, and Instructional world. That is, the “consensus-building” node is located in a different world from the learning and instructional theory defined in the OMNIBUS.

These descriptions reflect the structure of perceived and ideal states in the conceptual model for value co-creation shown in Fig. 1. The “consensus-building” node has a slot where a class constraint “proposition” plays the role of a “perceived state” in the service. The “consensus primitive” node, which is a subclass of “consensus-building,” has an “ASIS/TOBE” role holder, which is a specialization of the “perceived state” slot in the upper node. Moreover, this node is specialized as “consensus primitive in learning,” where the “object” of “ASIS/TOBE” is a teacher, a learner, or the learning contents/channels, in the service design context. These class constraints of the “object” are defined in the other part of this ontology. The “built consensus” node indicates a set of the ASIS and TOBE states. In the service design
context, this node is specialized as “built consensus in learning,” where the “holder” of each state is defined to be played by a teacher or a learner. Thus, the mental states in the conceptual model for value co-creation (Fig. 1) are defined, and relationships among primitive concepts such as the propositions playing the role of ASIS/TOBE are clarified.

Second, Fig. 6 shows hierarchy of consensus primitive in learning context. The top node “consensus primitive in learning” is the same as the node that has the same label in the Fig. 5. That is, hierarchy of consensus primitive is a part of hierarchy of concepts related to consensus building. The consensus primitives pertain to ASIS and TOBE states of teacher, learner, and content/channel in the case of an English lecture. These are conceptualized on the basis of conversations in an English lecture. The conversation data collected during counseling by Kimita et al. (2015) in an English lecture for twenty-three graduate and undergraduate students in the engineering department. The aim of the counseling was to enable the teacher to build consensus with the students. The conversation in the counseling touched on what kind of learning contents the student had worked on to date, and their reason for wanting to take the lecture. The students received the counseling twice and took the OPIc (Oral Proficiency Interview-computer) test to evaluate their English communication ability after each counseling session. We regarded topics that are pertinent to learning states agreed with the teacher and the student in the conversation as the consensus primitives.

As shown in Fig. 6, we extracted seven topics pertaining to contents/channel, three topics pertaining to teacher, and thirteen topics pertaining to student. However, the number of these consensus primitives will increase along with the progress of research into conversational data to explore what is value for learners and how it emerges in the learning service. Therefore, these descriptions will also be expanded along with the research progress in future work.

![Hierarchy of consensus primitives which are conceptualized on the basis of conversations in an English lecture.](image)

Third, the left half of Fig. 7 shows the hierarchy of quality and quality value of academic emotions. The structure of them is based on the quality and quality value on awareness shown in Fig. 4. According to the literature cited in Section 2, we newly defined nine emotions (enjoyment, boredom, anger, hope, anxiety, hopelessness, pride, relief, and shame) under the OMNIBUS. Furthermore, we also newly defined relationships between the nine academic emotions and the control and valence, as subclasses of the activity emotion and outcome emotion. Before defining the nine academic emotions, descriptions of the activity emotion and outcome emotion were imported into the OMNIBUS from our previous study (Muramatsu et al., 2013, 2015). The hierarchy of the activity emotions and outcome emotions are shown in the right half of Fig. 7. These descriptions provide the identities of each of nine academic emotions. Therefore, they are not associated with ASIS or TOBE states directly. That is, the quality and quality value of academic emotions can be used as vocabulary to represent ASIS or TOBE states.
The first and second kinds of concepts are defined under the “World of value co-creation” to be specifically distinguished from other worlds defined in the OMNIBUS, because concepts of the targeted world are conceptualized by different viewpoints. Accordingly, they are described in different grain size and are systematized as different hierarchy from the other worlds. On the other hand, the third kind of concepts are described under the “Common world” of the OMNIBUS. Because they are originally defined in our ontology on the basis of YAMATO, the viewpoint is the same as the “Common world.” Although they are described in other worlds, some concepts in the “World of value co-creation” consist of concepts that originate from outside the “World of value co-creation.” For example, nodes that are colored in light green such as “proposition,” “representation,” and “object” are defined in the “Common world” of OMNIBUS. Moreover, “perceive” which is a part of “value co-creation” is an “awareness-focused action” shown in Fig. 7. The “awareness-focused action” including the appraisal of academic emotions captures the quality and quality value of objects that are to be aware, and converts them into representations and propositions, because this is conceptualization of a kind of subjective evaluation (Muramatsu et al., 2015). Therefore, the third kind of concepts have a role to prepare representations and propositions pertaining to academic emotions that are referred to by the first and second kinds of concepts.

Fig. 7 Hierarchy of the quality and quality value of academic emotions (left) and the activity/outcome emotions (right).
5. Discussion

5.1 Instantiation of consensus building from conversation

Before evaluation of proposed ontological descriptions, we demonstrate instances of a consensus building on the basis of the ontology. Table 1 and 2 show conversations during counseling by a teacher (mentor) and a learner. They conducted counseling twice and their conversational data was collected by Kimita et al. (2015). “T” and “L” in the speaker column denote teacher and learner, respectively. As shown Table 1, teacher and student built a consensus pertaining to the student’s weakness in English skills and its improvement. While the student first reflected that his speaking skill is weak, he found that the listening skill is important to improve speaking skill through the conversations. The proposition that his speaking skill is weak is regarded as an ASIS state, and the proposition that listening skill is to be improved is regarded as a TOBE state of learner. In the second counseling, they built a consensus pertaining to the student’s weakness in English skills once again and feelings about taking the OPIc test, according to Table 2. As concerns the English skills, ASIS and TOBE states seem to remain unchanged. However, a new consensus, feelings about taking the OPIc test, was additionally built in this scene. That is, no anxiety for the test seemed to be an ideal TOBE state, and consequently the perceived ASIS state seemed to measure up to the TOBE state.

### Table 1 Conversations during the first counseling (one scene).

<table>
<thead>
<tr>
<th>Speaker</th>
<th>Contents of utterance</th>
</tr>
</thead>
<tbody>
<tr>
<td>T:</td>
<td>In terms of English skills such as listening, reading, writing and speaking, can you put these skills in order of your strength?</td>
</tr>
<tr>
<td>L:</td>
<td>Well, I think my listening and reading skills are better than speaking and writing skills. Speaking is my weakness point.</td>
</tr>
<tr>
<td>T:</td>
<td>I see, but your score of the previous OPIc test is not bad, it’s intermediate-high level.</td>
</tr>
<tr>
<td>L:</td>
<td>I could get such the results of other English tests recently, oh reading skill is better.</td>
</tr>
<tr>
<td>T:</td>
<td>You mean reading skill is the best.</td>
</tr>
<tr>
<td>L:</td>
<td>Yes, I thought I’m good at listening but actually it’s not...</td>
</tr>
<tr>
<td>T:</td>
<td>Really?</td>
</tr>
<tr>
<td>L:</td>
<td>Well, I often have a situation where I can’t truly understand what they ask in English so I can’t answer properly. This is why I’m trying to improve my listening skill.</td>
</tr>
</tbody>
</table>

### Table 2 Conversations during the second counseling (one scene).

<table>
<thead>
<tr>
<th>Speaker</th>
<th>Contents of utterance</th>
</tr>
</thead>
<tbody>
<tr>
<td>T:</td>
<td>In the previous counseling, you said listening and reading skills are better than speaking and writing skills, right? However it’s just turned out that listing skill is your weakness point.</td>
</tr>
<tr>
<td>L:</td>
<td>That’s right.</td>
</tr>
<tr>
<td>T:</td>
<td>Which materials do you usually use for reading aloud training?</td>
</tr>
<tr>
<td>L:</td>
<td>It depends on my mood...I read aloud “TED” contents in the last winter.</td>
</tr>
<tr>
<td>T:</td>
<td>Oh, “TED”! (snip)</td>
</tr>
<tr>
<td>T:</td>
<td>We have your second OPIc test on July 18 after the last lesson. I guess you don't feel a lot of pressure when you speak English, don't you?</td>
</tr>
<tr>
<td>L:</td>
<td>I don’t feel it.</td>
</tr>
</tbody>
</table>

Instance models of consensus building in the first and the second counseling session are shown in Fig. 8. The blue nodes indicate instances of the upper nodes. Each slot of the instance is filled with an instance of the class constraint. The left half and right half of Fig. 8 indicate instances of consensus building in the first and second counseling sessions, respectively. In the first session, consensus consists of an ASIS and a TOBE. Both are assigned “english skills (reading, listening, writing, speaking) (instance1)” and “english skills (reading, listening, writing, speaking) (instance2)”. These instances are instantiation of “english skills (reading, listening, writing, speaking)” shown Fig. 6. The reason they are numbered as instance1 and instance2 is to be distinguished from each other which exist.
independently. The ASIS state is specified by “perceived learning state” played by the instance of “speaking skill is weak” and the TOBE state is specified by “perceived learning state” played by the instance of “listening skill is to be improved.” The second consensus shown in the right half of Figure 8 has the same set of ASIS and TOBE. Since the ASIS and TOBE state pertaining to English skills are seems to be exactly the same, instances assigned to them are also exactly the same. The difference between the first and second concerns the ASIS and TOBE state of “taking OPIc test.” These states are assigned the same “taking OPIc test (instance),” and have the same “perceived learning state” played by the same instance of “no anxiety for the test.” Furthermore, the “no anxiety for the test (instance)” is referring to the same “academic emotion” played by the same “no anxiety (instance)” which is an instance of “anxiety quality value” shown in Fig. 7.

As a result, the contents of consensus which can be extracted from the conversational data are instantiated with no syntax and ontological error. That is, the proposed ontological descriptions, (i) concepts related to consensus building and specializations in the service design domain, (ii) concepts related to consensus primitives to be shared by teacher and students, and (iii) concepts related to the quality and quality value of academic emotions, are logically coherent.

![Fig. 8 Instantiation of built consensus and learning state in an English lecture.](image)

### 5.2 Metamodel for co-design processes in a learning service

As shown above, the actual contents of consensus building in a learning situation are to be instantiation on the basis of the ontological descriptions. Although the example is part of a conversation between the teacher and the student in the counseling session, other topics found in the counseling and learning states agreed by them also can be made instantiation in the same way. The descriptions developed in the current study can only cover narrow concepts in the fields of service engineering and marketing. However, they describe a core part of value co-creation in the field of learning service, particularly as a part of reaching a consensus between a provider and a receiver, which is essential for value co-creation. In particular, the contents of mental states, which are ordinarily invisible in learning activities, can be represented by our ontological descriptions. This will be very important and useful for designers because the ontological descriptions provide the meanings of concepts and relationships between concepts in the learning domain, which is unified under a top-level ontology. Based on the ontological descriptions, the learning states (ASIS and TOBE) can be described under the nodes of “consensus primitive in learning” and “built consensus in learning”, which provide common contents of consensus building with a model of learning states. Therefore, the proposed ontological descriptions are adequate to represent consensus building that pertains to learning states. In addition, the “consensus building” and “value co-creation” reflect the structure of the conceptual model for value co-creation shown in Fig. 1. Namely, the former corresponds to the lower half and the latter corresponds to upper half of the model for value co-creation. In this sense, proposal descriptions are feasible to provide metamodels of co-design processes in the
learning service design.

5.3 Conceptual framework for common language

In the sense of common language mentioned in the introduction, the proposed ontological descriptions do not sufficiently support vocabulary or a lexical level of descriptions, because we focused on a conceptual level of ontology, as mentioned in Section 2. However, they are feasible to provide concepts which could be used by multi-disciplinary stakeholders. That is, the proposed ontology can play the role of a conceptual framework for sharing knowledge on mental states of teachers and learners. The ontology represents the contents of knowledge in stakeholders’ minds when they build a consensus between them. For example, Kimita et al. (2015) analyzed the process of consensus building in an English lecture, and visualized a strategy for consensus building with a model of learning states (Fig. 9). This model illustrates the learning state transitions of the learners, and consists of two elements: learning states and instructional/learning events. The learning states are described from the viewpoint of teacher (provider), learner (receiver), and learning contents/channels, and include a current state (ASIS) and an ideal state (TOBE) in each viewpoint. The learning states in this paper are indeed the knowledge to be shared by multi-disciplinary stakeholders, such as teachers, learners, and researchers for designing learning services. Thus, the proposed ontology will play the role of a conceptual framework to make and use the application to visualize the learning states of learners and to support consensus building between teachers and learners. The remaining issue is to expand and improve the concepts of consensus primitives reflecting topics seen in consensus building between teachers and learners to make the conceptual framework more applicable. As mentioned in Section 4, our ontology has a limit to the number of consensus primitives, because they have to be identified from investigation of conversational data to be described ontologically. Therefore, the coverage of the consensus primitives will increase along with progress of the research to explore what is value for learners and how it emerges in a learning service.

Fig. 9 A model of learning states in a learning setting (reproduced from Kimita et al. (2015)).

6. Conclusion

In this study we have proposed ontological descriptions of receiver states for sharing knowledge in learning service design, and conceptualized elements of consensus building and value co-creation according to the conceptual model of value co-creation proposed by Nemoto et al. (2014). As a result, we have obtained a metamodel for co-design processes in the learning service design. The ontological descriptions can only cover narrow concepts in the fields of service engineering and marketing. The current study simply proposed the descriptions as a conceptual framework of the knowledge sharing on learning states including academic emotions. However, they offer the prospect of contributing to the shared knowledge on their learning activities between teachers and learners, through better understanding of concepts consisting of applications.

In the future, we will extend our descriptions of various mental states to include academic emotions studied in the field of educational psychology, for a better understanding of value co-creation and learning service design. In addition,
we will collect conversational data pertaining to consensus building between teachers and learners, and will identify much wider consensus primitives to represent topics seen in the conversation. Moreover, we will develop a subset of this framework which is oriented to symbol-level ontology for more practical usage, because the OMNIBUS ontology which we referred to and the top-level ontology YAMATO have structures that are too complex and precise for the developers of software applications. After that, we will assess the validity and utility for the design and implementation of software applications by using the subset.

Acknowledgments

This work was partially supported by JSPS KAKENHI Grant Numbers 25540165 and 16K00367, and JST/RISTEX Service Science, Solutions and Foundation Integrated Research Program (S3FIRE).

References


Mizoguchi, R., YAMATO: Yet another more advanced top-level ontology, Proceedings of the Sixth Australasian
Ontology Workshop (2010), pp.1–16.