Original Research

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# Developing STEAMS (Science, Technology, Engineering, Arts, Mathematics, and Sports) human resources through university physical education classes:

## Qualitative analysis of perceptions of learning

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**Abstract**

This study considered the significance of learning through the body in university physical education by examining university students' perspectives on learning and its role in STEAM(Science, Technology, Engineering, Arts, and Mathematics) education. Such an attempt was not simply to explore the contents and methods of university classes and propose solutions to problems, but also to question the existing framework of university physical education learning, to find a fusion point between university physical education learning and STEAM education learning, and to examine how to recognize the value of university physical education learning today as one perspective, given the shift toward learning that creates value. Eighty-two first-year students who took a practical physical education class at a science and engineering university agreed to participate in the survey. Interviews were conducted at the teaching site using face-to-face, one-on-one, semi-structured, open-ended, in-depth, and focus group. Informal onsite interviews were conducted during breaks. As a result of the analysis of university students' perceptions of university physical education learning obtained through interviews, it was found that learning through the body and exercise has a relational structure in which students deepen further questions through various ways of knowing, and experience joy in doing so. It was found that the uniqueness based on physicality and awareness of the body expressed by science and engineering university students' view of university physical education could be positioned as STEAMS(STEAM + Sports) education that develops a new element of creativity in STEAM education. It was inferred that there are clues to the uniqueness of university physical education learning in these points. This suggests that in terms of fostering creative human resources at universities, it is important to set up learning opportunities rich in such diversity, guarantee opportunities to deepen questions, and question the nature of STEAMS education that accumulates experiences that fascinate people to create.

**Keywords**

STEAMS education, qualitative data analysis, perceptions of learning

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## Introduction

Advanced technology has fully penetrated the culture of most societies; and the increasing maturity of artificial intelligence, Internet of Things, and big data has necessitated IT-based human resources to promote industrial structural reform (Ministry of Education, Culture, Sports, Science and Technology, 2018). The heightened demand for "science, technology, engineering, art, and mathematics," collectively known as STEAM education, as well as design thinking indicates this new direction—one that is beyond the framework of the conventional "humanities and sciences" in the general education realm.

Japan is among the countries that have prioritized STEAM education, as evidenced by a series of new curriculum reforms that emphasize inquiry-based and creative learning over simple knowledge transfer (Curriculum

Division, Elementary and Secondary Education Bureau, Ministry of Education, Culture, Sports, Science and Technology, 2021). The indication from the Ministry of Education, Culture, Sports, Science and Technology (2018) on learning that integrates the humanities and sciences and that from the Ministry of Economy, Trade, and Industry on the importance of learning as a cycle of "knowing" and "creating," are two such examples.

It is important to view STEAM education from a perspective that places the arts at the center of interdisciplinary education and "emphasizes the creative, cross-disciplinary, problem-solving, issue-based, and project-based aspects of learning" (Henriksen, 2017), rather than one that merely incorporates the arts into sciences and mathematics.

"Arts" can be defined as design thinking, music, visual arts, dance, and theater; it may also conceptually encompass the body, liberal arts, and civic culture (Yamazaki et al., 2016). In our examination of the role of university physical education as a liberal arts education, we define the arts as "creative thinking and expression that includes the body, the arts, and the liberal arts." We thus define STEAM education as a cross-disciplinary, comprehensive, and exploratory educational framework that creates new value through the fusion of scientific, physical, artistic, and creative thinking.

Broadly, there are two approaches to STEAM education: (1) blended education that combines the arts with STEM education promotion as the axis for learning issues, and (2) inquiry-based learning that transcends the framework of existing subject areas. This study explores the potential of STEAM education as an inquiry-based learning approach that transcends existing frameworks in order to understand university liberal arts education and physical education from the perspective of its multifaceted nature. Our intent is to contribute toward fostering human resources that can demonstrate creativity.

One such method in STEAM education is the design thinking, which emphasizes keywords, such as intuition, emotion, value, ideas, and transmission. A feature of this approach is that students are actively conscious of being taught, studying, or remembering, and that they are having fun, discovering problems, forming ideas, giving shape to ideas, and creating things. The directional objective of STEAM human resources development depends on how students demonstrate their creativity autonomously, and how doing so promotes independent and thorough study. However, theoretical class research on the development of STEAM education in Japan is scarce (Shirai, 2020). While such discussions on STEAM education are expanding in university education, the role of physical education in this field is also being reexamined.

Within the Japanese context, we do find a modest contribution of important studies, such as an examination of the positioning of university physical education (Japanese Association of University Physical Education and Sport, 2010), on issues based on the current status of university physical education classes (Nara and Kiuchi, 2021; Hashimoto et al. 2012; Sugiyama et al. 2001; Ishida et al. 2002 etc.), on the subjective benefits for students (Nishida et al., 2015), and on the methodological outcomes and significance of classes in university physical education practical skills (Nara and Kiuchi, 2020; Kiuchi et al., 2009).

The main issue we face is the significance and effectiveness of university physical education classes. We believe that university physical education in the future society should be considered from the lens of STEAM because such education prioritizes creative human resources, citizens with expertise and culture, and holistic education through the cultivation of the mind and body required for future university education. Therefore, it is important to re-examine university physical education, which has the unique characteristics of learning through the body and movement, in the discussion of STEAM education in order to fully grasp the significance of university physical education.

In two separate studies, Kitamura and Takahashi (2018) and Kitamura (2020) propose integrating scientific and sensory knowledge into the classroom. Examining the state of university physical education within the STEAM education framework, he suggests the following three directions: (1) classes that utilize "knowledge" related to university physical education, such as physical education and mathematics, physical education and physics, and physical education and cognitive science; (2) classes that utilize "knowledge" within university physical education by integrating physical education and specialized approaches such as movement analysis and tactical development; and (3) classes that uncover "knowledge" inherent in university physical education, such as the transfer of tacit knowledge and the verbalization of tricks (Kitamura, 2020). However, the learning experiences of university students have seldom been explored through a focus on the arts; how STEAM education is integrated and developed with physical education learning remains unclear owing to a paucity of studies.

This study clarifies how college students in science and engineering departments view college athletics. We investigate their perspectives on learning, and reconsider the nature of college education for the development of STEAM human resources. In other words, this study seeks to understand the significance of learning through the body in college athletes from the perspective of

STEAM education by examining the views of learning held by college students.

The qualitative research method is appropriate to analyze factors related to participants' inner experiences in university physical education classes. In general, the purpose of quantitative research is to identify general laws and, based on these laws, explain events in various fields and predict events that will occur in various situations (Kubota, 1997). Qualitative research can help us "understand how people perceive reality in a given situation and how they interact with that reality, respecting their subjective positions" (Kubota, 1997). Tagaki (2015) astutely notes that qualitative research is not a positivist position, which is the perception of the real world as something observable and measurable, but that the real world is socially constructed by people, and truth is an interpretation constructed by gathering information through mutual negotiations between the researcher and the participant. Informed by such constructivism, we employ qualitative research to understand and describe college students' learning experiences.

## Methods

### Participants

Eighty-two first-year students who took a practical physical education class at a science and engineering university in the Kanto region in 20×× agreed to participate in the survey. The physical education classes taken by the participants in this study were elective courses in the liberal arts education curriculum offered in the second semester of the first year (September to January of the following year). The subject of this study was a weekly face-to-face class that aimed to improve basic physical fitness and acquire basic motor skills through basic and game-style practice in ball games (soft football and tennis).

### Data collection

When conducting qualitative research, it is necessary to conduct interviews in a "natural state" (Kubota, 1997). In other words, "a keen methodological stance on the relationship between oneself and others and reflexivity" (Yamada, 2004) should dictate how one relates to the research participant, or "how the researcher contextualizes and interacts with the participants determine the quality of the field and data" (Yamamoto, 2004). Therefore, the researcher and participants were positioned in the natural state of a university physical education class, and the role of the researcher in the field was to act as a member of the class. That is, the researcher's position is to "take the role originally planned in the field and engage with the participant through that role" (Yamamoto, 2004).

An overview of STEAM education was provided to participants in the first class. Prior to the interviews, the purpose and method of this study were explained to all participants, and the interviews were conducted before and after the classes. After a preliminary explanation of the purpose and method of the survey, interviews were conducted by the author, who had been practicing qualitative research for 25 years before and after the classes, according to a developed interview guide. The interview questions were structured into three types: main questions that addressed central themes; follow-up questions that were asked in response to the core question and clarified in greater detail by repeating keywords or phrases in the response; and a probe that asked for more detail, traced its meaning, and developed new related questions. The interview was conducted such that the interviewer could move flexibly from one question to another depending on the flow of the interview.

The main questions are structured as follows:

(1) What do you consider the characteristics of science and engineering disciplines in universities and university physical education? Please feel free to tell us anything that may come to mind.

(2) What do you think are the points of contact between science, engineering, and university physical education?

Following the responses to these core questions, follow-up questions were developed. Examples of the follow-up questions were as follows: "Can you describe your feelings at that moment?"

Interviews were conducted at the teaching site using face-to-face, one-on-one, semi-structured, open-ended, in-depth, and focus group. Informal onsite interviews were conducted during breaks. Each interview lasted approximately 5–15 min and was conducted multiple times during each class period.

Although the number of people who could be interviewed at each class session was limited, all participants were interviewed throughout the ten classes. In terms of the variation in the participants' learning experiences at the university owing to the time difference between the 10 classes, the participants had experienced learning in their specialized fields at the university for six months prior to the interview, and their speech was based on such an experience, so there was no time difference.

Rather than taking the intentionalist position that meaning is an entity that independently exists inside an action and is discoverable, we decided to focus on the mutual exchange nature of the interview from the standpoint that the interviewer and the participant jointly generate the narrative, and to include all utterances in the

analysis.

During the interview, the participants were informed that their cooperation in the survey was voluntary, that they could refuse or withdraw at any time, and that the study would use anonymized data. Consent to use personal data for research purposes was obtained through ethical considerations.

## Data analysis

We followed the qualitative data analysis methods described by Côté et al. (1993). After the interviews, the audio data were immediately transcribed and a verbatim transcript was generated. After carefully reading the verbatim transcripts in context, the parts of the text that expressed the participants' experiences and perceptions of learning at the university, which was the purpose of this study, were divided into a single coherent group of sentences as a data unit of meaning. The goal is to distance the analyst from the linguistic data by separating them from their context. Data obtained from informal onsite interviews were used to create meaning units. Each meaning unit was assigned a title as a straightforward expression of semantic cohesion of the meaning unit. Next, we grouped meaning units into subcategories by considering the context of the utterance, and then grouped them into several subcategories with high affinity and similarity. The resulting subcategories were grouped based on their high affinity. The concepts were integrated into categories, while considering the level of abstraction and awareness of the unification of dimensions. Figure 1 illustrates the process of our analysis. The upper row of each process shows the content of the analysis, the left column of the lower row shows the analysis, and the right column shows the products created by the analysis.

## Validation methodology

To verify the methodological quality of the qualitative research, we examined the quality of the research and the certainty of the data analysis by means of "credibility" and "certainty," than by "reliability" and "validity," as in quantitative research. This is because quantitative and qualitative research use different paradigms: objectivism and constructivism. That is, in qualitative research, "people's experiences (reality) do not exist as facts independently of their participants, but are viewed as pluralistic things that are subjectively interpreted and internalized through social contexts and interactions with others" (Imafuku, 2021), which requires different evaluation criteria than those of reliability and validity based on the quantitative research paradigm.

In this study, with regard to "whether the research results accurately depict the 'truth' constructed by the people being studied" (Kubota, 1997) and "the verification of authenticity in terms of the realism of the data obtained" (Flick and Oda, 2011), we think that the interviewer and the participants themselves reflected on their experiences while building a relationship through multiple interviews. In the building process, they reflected on their experiences and generated narratives that were in line with the facts of their experiences, and the credibility of the data was enhanced through the accumulation of thick descriptions.

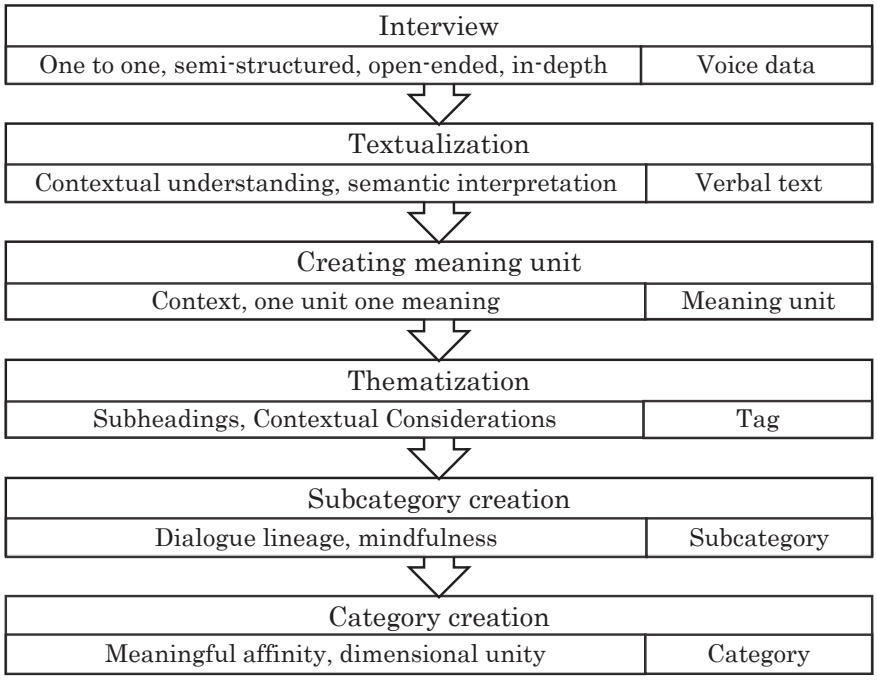


Figure 1 Data analysis process

Thus, in qualitative research, "meaning is not a reality that is kept inside the human being, but emerges in the interaction between the narrator and the listener" (Yamada, 2004), "truth or fact is assumed to depend on context" (Tagaki, 2015), "the narrative that is the object of analysis is not a projection of the narrator's internal state, but is constituted by the interaction with the listener, the socio-cultural context that surrounds both" (Tagaki, 2015), "the narratives that are the object of analysis are composed of the interaction with the listener and the socio-cultural context that surrounds both, rather than being a projection of the narrator's internal state" (Tagaki, 2015), and by "establishing a relationship of empathy and trust with the research participant" (Kubota, 1997), "wrong or distorted information is not received" (Kubota, 1997).

Regarding the certainty of the data and procedures, which "relates to whether or not the research methodology was rigorously conducted" (Kubota, 1997), the data analysis process was shared with multiple researchers with more than 20 years of experience in qualitative research methodology, and the analysis was conducted through multiple discussions and multiple validations. This made it possible to "ensure that the researcher's personal values and biases are not mixed in with the research findings and is thought to have increased certainty regarding the data analysis process" (Maxwell, 2013). To increase certainty, the analysis was supervised by an expert who has been conducting qualitative research for over 20 years.

## Results

Our analysis identified 194 meaning units. All meaning units were classified into six subcategories: knowing with the five senses, various ways of knowing, the diffusion of ideas, exploring questions, excitement and immersive pleasant experiences, and joy after suffering. These were further classified into three categories: various way-of-knowing experiences, exploratory experiences, and appealing experiences. The following sections discuss university students' views on learning based on these categories. For convenience, categories are marked with brackets [×], subcategories with double quotations "×", tags with chevrons <×>, and meaning units with single quotations '×'. Regarding the number of responses to an utterance, the object of consideration in this study is the "meaning" in the response, and "even a concept found only once is evaluated as an important concept depending on its comprehensiveness, symbolism, association with other concepts, persuasiveness to events and actions, and a strong relationship with known important concepts" (Otani, 2017). From our standpoint, we will not indicate the number of times but only the category items.

### Various ways of knowing experiences

The participants described the nature of university physical education, with its "various ways of knowing," as a characteristic of learning through the body, where awareness and understanding are obtained through "knowing with the five senses."

The category of [Various ways of knowing experiences], which integrates these narratives, consists of two subcategories, "knowing with the five senses" and "various ways of knowing," and was created to express ways of knowing, including ways of utilizing one's own body, such as positioning the senses in university physical education learning, understanding and mastering movements through the body, experiencing them, formulating strategies for achieving tasks, and materializing them through expression using one's body.

One of the participants described the experience of sensory "knowing" as follows.

> *To master movement, it is important to know the sensations of the body. The sensation can be visual or kinesthetic, and differs from person to person. Even if you understand it in your head, it is difficult to express it with your body.*

Another participant, referring to the sensation of the tools extending to the body, said:

> *In physical education class, I tried an event that I had never experienced before. I felt uncomfortable with all the movements, but at first the ball did not hit the racket at all, and I felt the racket was in the way. But gradually the racket began to feel like an extension of my hand, and eventually the moment the ball hit the racket it felt like it was hitting my hand.*

One participant also described a sensory experience as follows.

> *There are times when I feel the sensation of my own body. It is as if they become one with their own body and communicate with it. It's like a flash of inspiration, or a sensory understanding, or something like that.*

One participant who talked about the knack of movement in relation to learning through the senses said

> *The knack of movement requires subtle sensory control, and it takes time to be able to do that […] t*

Table 1 Hierarchical category listing

| Category | Subcategory | Representative meaning units |
|---|---|---|
| Various ways of knowing experiences | Knowing with the senses | To master movement, it is important to know the sensations of the body. |
| | | Gradually the racket began to feel like an extension of my hand, and eventually the moment the ball hit the racket it felt like it was hitting my hand. |
| | | I have the same kind of intuitive inspiration, the same kind of highly accurate sense of how something should be done. |
| | Diverse ways of knowing | There are times when I feel the sensation of my own body. It's like a flash of inspiration, or a sensory understanding, or something like that. |
| | | It is important to have a sense of detail, as well as a sense of flow, so to speak, in the image of the entire movement and how to exert strong and flexible force. |
| | | There is an aspect of learning physical education in which actual movements are repeated over and over again to get a sense of what is going on in the body. This is what makes it different from specialized studies. |
| Exploratory experiences | Diffusing ideas | Even if you feel like you have some idea of what you are doing, when you actually do it, you may find that you are not quite up to speed yet, or you may discover new issues to be addressed. It's like you become aware of it. |
| | | I hit the ball with all my senses. In doing so, I find that what I "think I am doing" is not what I am actually doing. |
| | | I need to have a variety of ways of looking at the ball: from the distance, outside the court, where I can anticipate the trajectory of the ball, position my body on the court, see the ball and hit it; and from the inside, where I can get inside the racket and feel my own body. |
| | | In specialized studies, when I get absorbed in something, my perspective sometimes becomes narrow and I get stuck, so I try to distance myself a little and look at it from different fields and perspectives. |
| | Deepening inquiry | I often make mistakes. When that happens, I think hard about why I made the mistake, where the cause is, what I can do to improve, and what I need to pay attention to. |
| | | I think it is important to correct the misalignment in order to understand and be able to do so. The first prerequisite is to become aware of the misalignment. After that, I think it is a good idea to gradually focus on it. |
| | | It is a very good cue for me to think and practice on my own, as my peers point out things that I am not aware of. |
| Fascinating experiences | Exciting and immersive pleasant experience | It is not just trying to reproduce a given correct movement, but the process of thinking this way and that, not giving up, and continuing to look for ways to do it better, or to do it better, is fun. |
| | | In my case, I like to know the unknown. I think learning about physical education would be more exciting if there was a way of knowing that stimulates curiosity. |
| | | I was depressed because I could not hit the ball very well. One day, I swung the bat as hard as I could and the ball hit the ground. At that time, I was more happy that my friends were so happy than that I got a hit. |
| | Joy after suffering | In class, I often get stuck because I can't do the move I want to do well. At such times, I would observe the movements of my classmates and try to get a feel for them by tracing the movements with my imagination. When I was able to do it, I was very happy. |
| | | It is difficult because even one's own body does not always move as one would like, but when one overcomes this difficulty and is able to do so, one feels as if one has finally connected with one's own body. |
| | | If you don't try to figure it out right away, but keep asking why and why not, you may have an epiphany. It is important to struggle. |

*is just like studying in a specialty field: you accumulate what you can do and then you understand the whole picture.*

He overlapped the importance of accumulating through trial and error with the study of specialty fields in science and engineering.

Another participant, in discussing the "various ways of knowing," mentioned learning the tricks of the trade, saying,

*It is important to have a sense of detail, as well as a sense of flow, so to speak, in the image of the entire movement and how to exert strong and flexible force.*

Another participant said, "There are things that look like actual body movements and things that don't look like the sensation of moving," and he described "various ways of knowing" as a characteristic of physical

education learning, saying, "We grasp the sense of knowing and being able to do things in various ways, such as seeing, moving, feeling, imitating, touching, and so on." This is a characteristic of physical education. One participant described this point as "something like tacit knowledge."

The recognition that a sensitive and comprehensive sensory understanding, represented by such tacit knowledge, is required in the physical education of university students is also discussed in conjunction with the study of specialized fields in science and engineering. In this regard, one of the participants said the following.

> *When I study science and engineering, I have the same kind of intuitive inspiration, the same kind of highly accurate sense of how something should be done. I can't really explain it, but it's like I know what it is.*

Another participant said,

> *In science and engineering studies, you learn by breaking down phenomena into their elements, reconstructing them, and advancing your understanding.*
> *In science and engineering studies, there is a way to learn by breaking down a phenomenon into its elements, reconstructing them, and advancing your understanding, but there is also a way to suddenly understand. It is the same feeling as when you are playing in gymnastics and you think, "Oh, this is it."*

One student described the difference between learning in physical education and learning in a specialized area of science and engineering as follows.

> *While professional learning has an image of conceptualization and understanding of knowledge and skills, there seems to be a gap between that understanding and the reality of movement learning in physical education. It is as if we can't do something even if we know what we are doing. I think that is the difference.*

Another student described the differences between science and engineering as follows:

> *In my specialized studies, I learn by learning from various people, reading books, and actually touching and understanding through experiments and observations. In physical education, I feel that it is surprisingly difficult to reach the point of being able to do something just by doing that. I think the difference is in the repetition of exercises, or in the acquisition of actual movements over and over again to get a sense of what is going on in the body, or in the knowledge of the body.*

### Exploratory experiences

When students find clues to solving a physical exercise task sensitively and intuitively through a variety of knowing experiences, they become deeply involved in problem-solving behaviors, such as "I want to be able to do it somehow," "I want to become better at other movements," and "There must be another way to do it."

The category of "exploratory experience," in which these narratives are integrated, consists of two subcategories, "diffusion of ideas" and "exploring questions," and was created to represent the experience of further deepening the knowing and understanding experience, generating various ideas by thinking in various directions, and deriving the correct answer from the problem situation at hand. One participant described the experience of "diffusing ideas" as follows.

> *Even if you feel like you have some idea of what you are doing, when you actually do it, you may find that you are not quite up to speed yet, or you may discover new issues to be addressed. It's like you become aware of it. The reality of movement is complex and various factors are interrelated, so it is not simple. I feel that through actual movement, we can solve each problem one by one and come to understand.*

Another participant described the idea of using various senses to perceive one's own movements from multiple perspectives as follows:

> *I hit the ball with all my senses. In doing so, I find that what I "think I am doing" is not what I am actually doing.*

One participant captured his body and movements by widening and changing his perspective. In this regard, he states:

> *I need to have a variety of ways of looking at the ball: from the distance, outside the court, where I can anticipate the trajectory of the ball, position my body on the court, see the ball and hit it; and from the inside, where I can get inside the racket and feel my own body.*

Another participant, referring to his trial-and-error

experience, described how "deepening inquiry" leads to the learning of movement.

> *I often make mistakes. When that happens, I think hard about why I made the mistake, where the cause is, what I can do to improve, and what I need to pay attention to. Learning through trial and error is also a way to accumulate experience as I gain the knack of doing things my own way.*

One mentioned the usefulness of advice from others to "deepen the inquiry," stating,

> *I think it's a good thing to have advice from others to help you deepen the inquiry.*

One of the participants contrasted this experience of learning through repeated "diffusion of ideas" and "exploring of questions" with learning in a specialized field of science and engineering. He said,

> *In specialized studies, when I get absorbed in something, my perspective sometimes becomes narrow and I get stuck, so I try to distance myself a little and look at it from different fields and perspectives. In a sense, this may be the same as learning about movement.*

However, one student described the difference between learning in physical education and learning in a specialized area of science and engineering as follows.

> *There is a gap between what we think we understand and what we really understand, a gap between what we think we understand and what we do not understand, and such gaps also exist in professional learning. But I think the discrepancy is greater when learning about movement.*

> *I think it is important to correct the misalignment in order to understand and be able to do so. The first prerequisite is to become aware of the misalignment. After that, I think it is a good idea to gradually focus on it.*

### Fascinating experience

All of the participants mentioned the attractiveness of successful experiences, the "feeling of fun," and the "sense of fulfillment of having done something." They also describe the emotional impact of university physical education and its influence on stimulating learning. The fascinating experience category consists of two subcategories: exciting and immersive pleasant experiences, and joy after suffering. They were created to express their experiences of fun, excitement, accomplishment, and self-competence through their efforts to deal with the challenges they faced.

Regarding the enjoyment of physical exercise, one participant described the experience of being "excited" while experiencing the joy of physical exercise as follows:

> *I think the fun of physical exercise is in trying to figure out what the goal should be. It is not just trying to reproduce a given correct movement, but the process of thinking this way and that, not giving up, and continuing to look for ways to do it better, or to do it better, is fun. Maybe that's what it means to learn through one's own body.*

Another participant mentioned an experience in which he felt great joy when his peers praised him for something he had done, and described his "feelings of fun" as follows:

> *I was depressed because I could not hit the ball very well. One day, I swung the bat as hard as I could and the ball hit the ground. At that time, I was more happy that my friends were so happy than that I got a hit.*

Another participant, referring to his experience of finally succeeding after repeated failures and hard work, describes the "joy after suffering" as follows.

> *In class, I often get stuck because I can't do the move I want to do well. At such times, I would observe the movements of my classmates and try to get a feel for them by tracing the movements with my imagination. When I was able to do it, I was very happy. This is one of the charms of learning together with friends, rather than alone in university physical education.*

One of the participants contrasted these "excitement" experiences and "joy after suffering" with learning in the specialized fields of science and engineering:

> *Learning about your favorite specialty is exciting. It is intriguing and intellectually stimulating. In my case, I like to know the unknown. I think learning about physical education would be more exciting if there were ways to learn that pique my curiosity. For example, it would be nice to learn about the materials engineering of balls and bats, the mathematics of formations, the mechanics of the human body, and so*

*on.*

Another student described the difference between learning in physical education and learning in a specialized area of science and engineering as follows:

> *Physical education differs from specialized studies in that it involves the use of the body. In addition, it is difficult because even one's own body does not always move as expected, but when one overcomes this difficulty and is able to do so, one feels as if one has finally connected with one's own body. I don't think this is a specialized study.*

Finally, one participant mentioned the importance of the experience of struggling in learning, saying, "I think it's important to have the experience of struggling."

> *I can't do a movement that I can't do right away. So, I try to find out what it feels like while accepting the state of not being able to do something in a certain way. Then, I feel as if I can suddenly understand something, and that is when I start to be able to do it. The same thing happens in professional learning. If you don't try to figure it out right away, but keep asking why and why not, you may have an epiphany. It is important to struggle.*

## Discussion

This study considered the significance of learning through the body in university physical education by examining university students' perspectives on learning and its role in STEAM education. Such an attempt was not simply to explore the contents and methods of university classes and propose solutions to problems, but also to question the existing framework of university physical education learning, to find a fusion point between university physical education learning and STEAM education learning, and to examine how to recognize the value of university physical education learning today as one perspective, given the shift toward learning that creates value.

The results of the analysis revealed that science and engineering students' perceptions of university physical education comprised three categories: various knowledge experiences, exploratory experiences, and attractive experiences.

The participants of this study, university students in the fields of science and engineering, described their experiences of learning as college athletes, repeatedly pursued exploratory questions, and explored a variety of ideas while deepening their inquiry into the causes of failure and the nature of problems in their physical exercise experiences that did not easily lead to problem solving. Simultaneously, they repeatedly took a bird's eye view of the whole and a concentrated, in-depth pursuit of the particular. Such repeated experiences of diffused and convergent thinking are critical to cultivating creativity in STEAM education (Watanabe et al., 2019) and common sensory learning in health and physical education (Suzuki et al., 2014). In this regard, the participants reconfirmed the characteristics of university physical education learning as the construction of a new relationship through the body, in which they faced their own bodies and senses by solving problems such as unknown exercise experiences, various discomforts, and gaps in body sensation felt in the process of acquiring movements. At the same time, such points are seen as places for intuitive understanding and sensory learning experiences that can be applied to specialized learning in the science and engineering fields. They are challenged by the prospect of "I wonder if I can do this if I do this and that" and "Maybe I can do it if I do it like this," and by solving problems. They were trying to solve problems with their intuition, "Maybe if we do it this way, we can do it." This was not simply a process of blind trial and error with repeated failures, but rather a series of problem solving based on intuition and tacit knowledge, which led to a double-loop structure of learning that generated a new learning loop by involving sensory information in the hypothesis-testing loop (Kitamura, 2021).

Hiraku et al. (2020) note that these double-loop learning experiences are characteristic of the view of learning in college athletes, and it can be inferred that this is a factor highly relevant to the art approach in STEAM education. It is a way of learning that involves awareness and understandability through the senses, as well as knowledge and skills that can be understood logically; through many failures, it helps in integrating various ways of knowing and leads to comprehensive judgment (Kitamura and Takahashi, 2018), in which knowledge is based on the body.

This double-loop learning experience is common to the intuitive understanding of science and engineering; that is, it is an intuitive design thinking style, in which the whole is grasped by inspiration rather than by breaking it down into its elements and reconstructing it for understanding (Shirai, 2020; Kitamura, 2020). Furthermore, such body-based learning experiences lead to self-growth in that they bring about inquiry-based learning with diversity and comprehensiveness. This can be inferred from the fact that the participants felt a sense of self-competence as they became aware of their progress through accomplishment and success, and experienced an exciting emotional

experience in which they were exposed to the guts of movement, which led them to engage in further learning physical exercise with rich diversity and sophistication.

Based on this discussion, we believe that the double-loop learning experience expressed in body-based learning and the design thinking style expressed in sensory awareness through body movements, which are expressed in university students' views of university physical education, may be positioned as a STEAMS education that develops a new element of creativity thereof. Here, we find a clue to the uniqueness of the study of college physical education.

Figure 2 shows the relationship between the three categories as a tentative plan for STEAMS education in university physical education. The three categories in the center represent the elements of the participants' views on learning college athletics. STEAM education, as professional learning in the field of science and engineering that includes an element of the arts, overlaps with the view of learning among college athletes. Further, STEAMS education is presented to overlap with this view of learning among college athletes and STEAM education. The factors that relate learning in science and engineering fields, which are at the heart of STEAM education, to learning in university physical education have been shown to be unique, based on physicality in university physical education and awareness of the body.

## Conclusion

The structure of the relationship between science and engineering students' perspectives on learning in college athletes in this study was inferred to be one that deepened students' inquiries through various ways of knowing and experiencing joy in doing so. The results suggest that it is important to set up learning opportunities rich in such diversity, guarantee opportunities to deepen questions, and question the nature of STEAMS education that accumulates experiences that motivate people to create and develop creative human resources at universities. Practical implementation and verification of the concrete development of these issues will remain future issues.

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## References

Côté, J., Salmela, J.H., Abderrahim, B., and Russell, S.J. (1993). Organizing and interpreting unstructured qualitative data. The Sport Psychologist, 7: 127-137.

Curriculum Division, Elementary and Secondary Education Bureau, Ministry of Education, Culture, Sports, Science and Technology (2021). Promotion of cross-curricular learning such as STEAM education. https://www.mext.go.jp/content/20220518-mxt_new-cs01-000016477_00001.pdf, (accessed 2022-02-02).

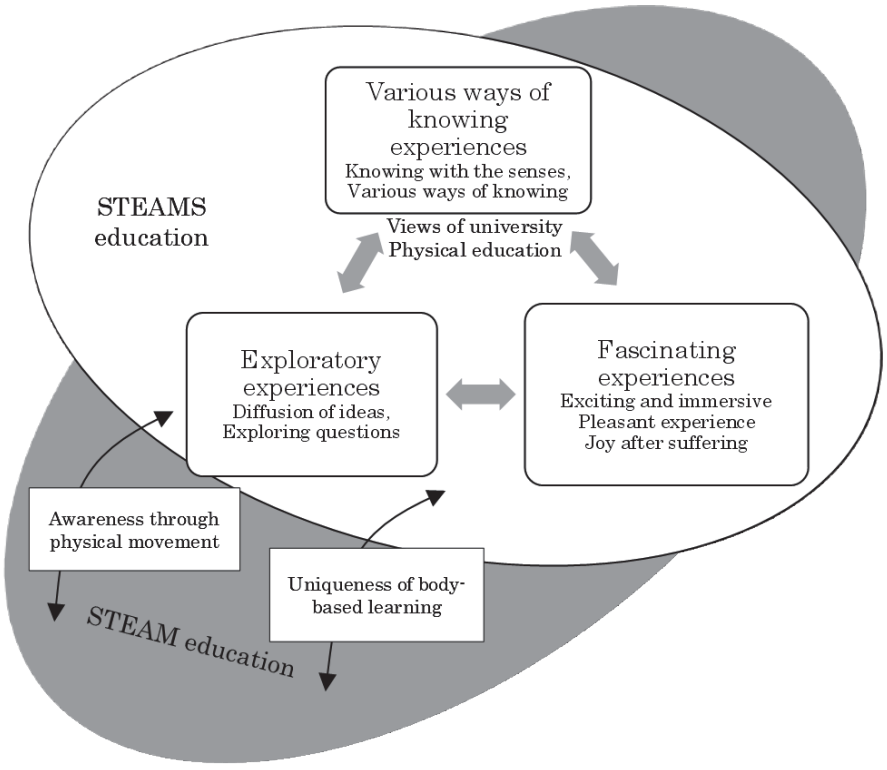


Figure 2 STEAMS model

Flick, U., and Oda, H. (St.) (2011). Sitsuteki Kenkyu Nyumon [Qualitative Research Method]. Shunjyu Publisher (in Japanese).

Hashimoto, K., Negami,Y., and Iiboshi A. (Eds.) (2012). Mirai wo Hiraku Daigakutaiiku [University Physical Education for the Future]. Fukumura Publisher (in Japanese).

Henriksen, D. (2017). Creating STEAM with design thinking: Beyond STEM and arts integration. The Science, Technology, Engineering, Arts and Mathematics Journal, 3(1): Article 11, DOI: 10.5642/steam.20170301.11.

Hiraku, S., Kobayashi, K., Kitamura, K., Nakayama, S., Tahara, R., and Kiuchi, A. (2020). New design of physical education in higher education. Journal of Japan Association for College and University Education, 42(2): 93-97.

Imafuku, R. (2021). Fundamental principles that you need to know when you undertake qualitative research. Japanese Journal of Pharmaceutical Education, 5: 1-6.

Ishida, H., Hoshijima, Y., Yano, H., Yonetani, S., and Kimura, K. (2002). How should be physical education in university: An elective tendency of the health and sports practice in K university. Kawasaki Medical Welfare Journal, 12: 311-319.

Japanese Association of University Physical Education and Sport. (2010). Taiikukei Gakujutsu dantai karano Teigen [Health, Physical Education and Sports in Higher Education in the 21st Century]. document volume: 32-37.

Kitamura, K., and Takahashi, R. (2018). Qualitative investigation of STEAM education and physical education in general education. Bulletin of Department of General Education. College of Science and Technology, Nihon University, 104: 11-22.

Kitamura, K. (2020). A qualitative study of STEAM education as talent education, focusing on mastery experience in the fields of science and technology. Journal of Research Institute of Science and Technology. College of Science and Technology, Nihon University, 122: 1-10.

Kitamura, K. (2021). What college physical education could do through online lessons in the COVID-19 pandemic: A qualitative analysis of students' view of university physical education course. Japanese Journal of Physical Education and Sport for Higher Education, 18: 35-48.

Kiuchi, A., Arai, H., Urai, R. and Nakamura, T.(2009). Effects of a behavioral science-based physical education program on the physical activity-related variables of college freshmen: Project FYPE. Japan Jounal of Physical Education, Health and Sport Science, 54: 145-159.

Kubota, K. (1997). A study on evaluation criteria for qualitative research : A paradigmatic perspective on research evaluation. Japan Journal of Educational Technology, 21(3): 163-173.

Maxwell, J.A. (2013). Qualitative research design: An interactive approach. 3rd ed. SAGE.

Ministry of Education, Culture, Sports, Science and Technology (2018). Human resource development for Society 5.0: Changes to society, changes to learning. https://www.mext.go.jp/component/a_menu/other/detail/__icsFiles/afieldfile/2019/01/24/1405844_003.pdf, (accessed 2022-02-02).

Nara, T., and Kiuchi, A. (2020). Design of university physical education courses intended to improve life skills through self-disclosure. Japanese Journal of Physical Education and Sport for Higher Education, 17, 38-47.

Nara, T., and Kiuchi, A. (2021). Effects of self-disclosure experience on life skill acquisition in university physical education courses. Japan Journal of Physical Education, Health, Sport Sciences, 66: 515-531.

Nishida, J., Hashimoto, K., Kiuchi, A., Tanimoto, H., Fukuchi, T., Kamijo, T, Onizawa, Y., Nakao, H., Kiyama, K., Arai, Y., and Ogawa, M. (2015). Extraction of the perceived benefits of university physical education classes by text mining: Differences in sex and exercise habits among the categories of perceived benefits. Japan Journal of Physical Education, Health and Sport Sciences, 60: 27-39.

Otani, T. (2017). What is qualitative research? Yakugaku Zasshi, 137(6): 653-658.

Shirai, M. (2020). Construction of learning for higher education in Japan. Bulletin of Faculty of Business Information Sciences, Jobu University, 19: 1-33.

Sugiyama, S., Kobayashi K., and Nara, M. (2001). The present situation and the problems of university physical education. Journal of the Physical Education and Sport Philosophy, 23(2): 1-15.

Suzuki, I., Watanabe, T., Watanabe, Y., and Okuma, S. (2014). Research on cross-curricular perspectives in learning activities that contribute to the development of "the ability to think, judge, and express. Bulletin of the Takehaya Junior High School, Tokyo Gakuen University, 52: 27-35.

Tagaki, M. (2015). Single-case research design and qualitative research: Combining qualitative research and behavior analysis. Japanese Journal of Behavior Analysis, 29: 233-239.

Watanabe, Y., Suzuki, I., and Okuma S. (2019). A consideration of cross-curricular efforts utilizing diffuse thinking through art education. Bulletin of the Faculty of Human Studies, Bunkyo Gakuin University, 20: 9-18.

Yamada, Y. (2004). What is at the heart of qualitative research? In Muto, T., Yamada, Y., Minami, H., Aso, T., and Sato, T. (Eds.), Qualitative Psychology, Shinyosha: pp.8-13.

Yamamoto, T. (2004). How to get into the field. In Muto, T., Yamada, Y., Minami, H., Aso, T., and Sato, T. (Eds.), Qualitative Psychology, Shinyosha: pp.66-71.

Yamazaki, S., Omori, Y., and Isobe, M. (2016). The interpretation of elementary school textbooks as authorized teaching matters from the viewpoint of STEM/STEAM education. Bulletin of Joetsu University of Education, 36: 203-215.

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# 大学体育授業による STEAMS（Science, Technology, Engineering, Arts, Mathematics and Sports）人材育成の展開：

## 学習観の質的分析

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**要　旨**

本稿の目的は，大学生のもつ学び観の検討を通して，大学体育における身体を通した学びの新たな意義を検討し，STEAM 教育（Science, Technology, Engineering, Arts, and Mathematics 教育：理数科学的思考と身体・芸術・創作的思考の融合により新たな価値創造を生み出す領域横断的で総合的な探索的教育の枠組み）の中に位置づけることにある．そうした試みは，価値創造型の学びへの転換が目指されている今日において，既存の大学体育の学びの枠組みを問い直し，その一つの視点として，大学体育の学びと STEAM 教育の学びの融合点を見出し，どのように大学体育の学びの今日的価値を認めていくのかを検討するといった意味を有している．理工系大学で体育実技の授業を履修した 1 年次学生82名を対象とし，対面による 1 対 1 の半構造的，自由回答的，深層的インタビューを実施した．インタビューにより得られた大学生の大学体育の学びに対する認知の分析を行った結果，身体および運動を通した学びは，多様な知り方を通し，更なる問いを深め，そこに喜びを体感するという関係性の構造をもつ点が見いだされた．そこから，理工系大学生の大学体育の学び観によって表現される，身体性を基軸とした独自性，および身体の気づきを通した気づきが，STEAM 教育に新たな創造性の要素を展開させる STEAMS (STEAM + Sports) 教育として位置づけられる可能性が見出された．ここに大学体育の学びの独自性の手がかりが推察された．そこから，大学における創造的人材の育成という点で，こうした多様性に富んだ学びの場の設定と，問い深める機会の保証，そして創造に魅了される体験を蓄積する STEAMS 教育の在り方を問うことが重要である点が示唆された．

**キーワード**

STEAM 教育，質的分析，学習観

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