

# Context Map: A method to represent the interactions between students' learning and multiple context factors

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In previous research, researchers have identified a wide range of context factors that could affect student learning, either independently or in combination. However, it is less clear how specific context factors may affect student learning or interact among themselves. To investigate this issue, we developed a tool called context map that provides a graphical representation of the effects and interactions of multiple context factors. We will show examples and discuss the implications of this method for research and instruction.

## I. INTRODUCTION

In previous research, it has been found that student learning can be significantly affected by context [1]. In addition, researchers have identified a wide range of factors that could affect student learning, either independently or in combination, referring to them as social/environmental, psychological, mental, or emotional context.

Dictionary-derived definitions define context as “the whole situation, background, or environment relevant to a particular event.” However, as noted by Cole, Griffin, and LCHC [2], context is an extremely complex and polysemous concept. Even though we know a number of context factors that might affect learning, it is still very difficult to answer such specific questions as “how many context factors are involved in a student’s learning? How do the context factors actively interact with student learning or among themselves?”

Thus, we need a method of representation to show the interactive relations between context factors and learning. The purpose of our research was to develop a tool, which we call a context map, to help us analyze and understand the effects of multiple context factors on student learning in physics classes.

## II. THE CONTEXT MAP

In our research, contexts are analyzed in terms of factors embedded in three types of settings, namely,

the learning environment, the content knowledge, and certain students’ and instructors’ internal states [3]. The context factors in the learning environment include specific settings of the education environment such as the teachers’ teaching styles, class formats, classroom climate, etc.

Context factors in the content knowledge refer to certain unique features of the knowledge to be learned by the students. For example, in the topic of classical mechanics, content based context factors are specific features of an scenario used or related to the learning and teaching, which often include things like the mass, the velocity, the sizes and shapes of an object, etc.

Students’ and instructors’ internal status are also considered as part of the context and are often called inner factors of students’ learning. These may include motivations, attitudes, previous and current knowledge states, past experiences, etc.

The context map is a graphical representation that shows the interactive relations among multiple context factors as discussed above. Figure 1 shows the structure of a context map. The dashed line represents the boundary between the inner area context factors and the outer area factors for a particular student. The student learning process occurs on this boundary, through interactions among the inner and outer factors (such interactions can be within and/or across the boundary). The process of learning is constantly affected the different interactions and vice versa. Among the factors of the

inner and outer areas, the ones closer to the boundary often have more direct effects on student learning. For example, in figure 1, the student's motivation has a more direct effect on his/her ways of learning than his/her previous knowledge. Notice that this tool is used primarily to analyze the process of student learning rather than the actual outcome of the learning process.

The following is a brief description of the procedures for using a context map as an analysis tool in research.

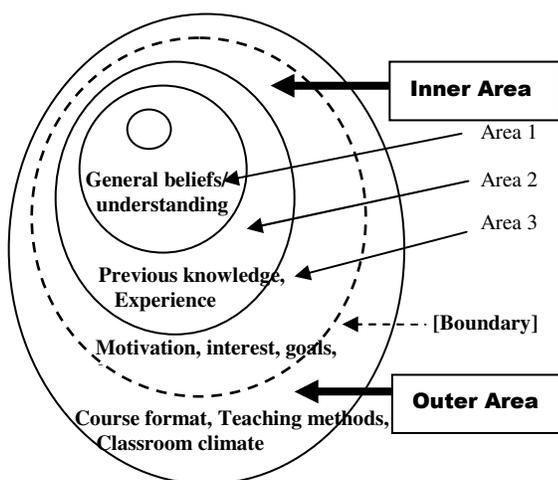


Figure 1. The structure of a context map

1. We use web-surveys and individual interviews to identify students' typical learning approaches.
2. In interviews and surveys, we ask students to self-report context factors that affected their learning based on their feeling of explicit involvement of those factors.
3. We introduce the context map to students in the interviews and ask them to use this map to reflect how they learn.
4. Finally in the interview, the researcher and the student construct a context map together so that the things being put up in the map and the interpretations of the map are all explicitly elaborated and agreed upon by both sides.

### III. RESEARCH

#### A. The Research Settings

This research was conducted in one quarter of an introductory physics course for freshman

engineering honor students at The Ohio State University. This 10-week quarter course covered classical waves and quantum mechanics. One instructor taught two sections of the course. Eighty-eight students were enrolled in the sequence. We used three web-surveys to measure how students learn physics and to identify the important context factors affecting their learning (see Table 1).

Table 1. Selected items from web-surveys

1. For the past 4 ~ 6 weeks, how did you study for this class?
2. Give some details on specific things (methods) you do (use) in your study and discuss the "helpfulness" of those things (methods).
3. For anything you do, there is always a "motivation" associated. Please give the major motivations (or goals) for your taking this class.
4. Please discuss any specific things from the teaching and learning that had positive or negative effects on your motivation. (I will then try to do more good things that keep you motivated.)
5. Consider the following factors. For each of them, rate the effects that it has on your learning in physics in this. Select a number between -2 and +2, (-2 for strong negative effects, +2 for strong positive effects, and 0 for no effects).

#### Issues about yourself

- General abilities related to learning
- Previous knowledge, past experience related to the present topics or problems
- Interest in specific content topics of the course
- Motivations
- Goals in taking this course
- Fear of not doing well
- General beliefs on how one should learn: e.g., who should be guiding the learning?
- General understandings about the structures of science knowledge and how such knowledge is developed

#### Issues about the learning environment

- Features of the specific content or concepts you are learning
- Course structure/format
- Amount of time allowed and/or expected for learning
- Teaching methods in this course
- Classroom climate
- Causes of certain kinds of stress (for example, workload)
- Web-survey and homework feedback in this class
- Features of exams (formats, difficulty levels)
- Your expectations for the new homework system
- Expectations of parents, etc.

We also observed every class to see how students learn in the classroom. Five students participated in weekly based individual interviews. Each interview lasted about 30 minutes. From these interviews, we obtained a detailed understanding of the students' learning approaches.

Starting from the middle of this course, the main task of each interview was to work with each student to construct a context map that reflects the students' learning in this class. Students placed the important factors that affect their learning into the context map according to the levels of their direct effects. With the basic structure of the identified context factors, we then investigate the interactions among those context factors. We asked the students additional questions such as "How do those context factors in the context map affect your learning and interact with each other?", "What is the main interaction and why?"

### B. Results

Using the procedure for constructing a context map, we made context maps with five students. Figure 2 shows two of these students' context maps. There are some differences among the context maps. For instance, in the case of student B, he usually tried to understand physics concepts deeply. However, according to him, factors such as fear of failure, interest in specific physics topic (e.g., the uncertainty principle), and general structural understanding of the knowledge have a direct effect on his way of learning. Therefore, his learning often changed depending on these context factors in different learning situation. Moreover, general ability and previous knowledge had some effect but the effects were considered indirect.

As for the interactions among different context factors, interest and goals strongly interact with each other in the inner area. There are many interactions between fear of failure and course stress, and among structural understanding, teaching format, specific concepts, and classroom climate in the outer area. For instance, he said, "When I have stress from a test, I feel fear of failure. But if I am interested in a concept, then it is OK. I study hard."

For instance, in the case of student E, context factors such as general ability, interest in physics, and general understanding about the structure of science have direct effects on the student's learning.

In comparison to student B, student E was affected by a set of different context factors. He is the only one (among the five students) who considered that his learning was significantly affected by one of the personal epistemology in terms of the understanding about the structure and developmental process of science.

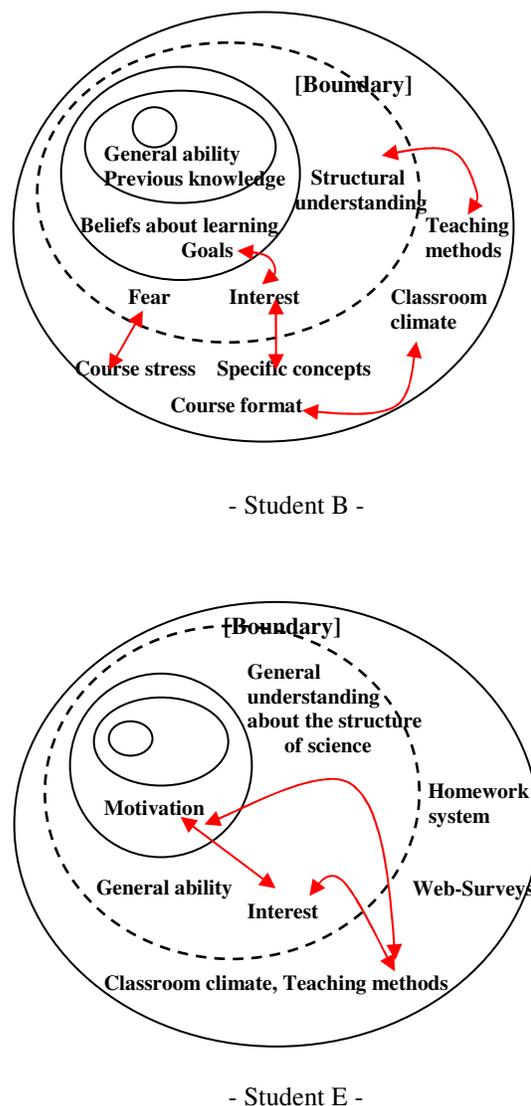


Figure 2. The context maps of two students (B & E)

Motivation also affects this students' learning. He was active in learning with a strong interest in the course content and also tried to manage time and effort effectively to maximize grades. As for the interactions among the context factors, there are close relations between interest, motivation, and specific teaching methods. For example, demonstrations in the class attract his interest, and

increase his motivation to study the materials being taught.

We conducted individual interviews with five students. Although each student's context map has its unique features, we have found some commonalities among the context maps of the five students. In general, in the inner area of each student's context map, affective factors (motivation, fear, interest, goals, etc.) are placed close to the boundary, which means that these factors were considered by students to have direct effects on how they learn. On the other hand, previous knowledge, beliefs about learning, and general ability are placed far from the boundary, which means that these factors do not have direct effects on how the students learn. In the outer area of the context map, teaching methods, course structure, and classroom climate directly affect the learning process. As we compare the five students' context maps, even though the specific interactions are different, we can see a general pattern similar to figure 1.

In summary, as shown from our study using the context map, abstract factors like general beliefs about learning were considered to have less direct effects comparing to concrete or affective factors such as interest in specific content topics, motivation, goals, fear of not doing well. In addition, we also observed that individual students' learn in different manners which are affected by the combined effects of a wide range of context factors.

#### IV. CONCLUSIONS AND IMPLICATIONS

From this study, we find that the context map is a useful tool to analyze the effects of multiple context factors on student ways of learning. The research results suggest that affective factors have more direct effects on how a student learns than abstract factors such as epistemological beliefs. The effects of external factors have less commonality and are more dependent on the individual students. We also find several interactions between students' learning and contextual factors and among the contextual factors themselves.

The context map can also be used as a tool to help instructors understand the complex dynamics of interactions in student learning, and prepare effective instruction based on this understanding. In our research, we explicitly introduced this tool to the

students in our interviews. We found that students can benefit from the context map as it helps students recognize how they learn: What are the important factors affecting their learning? How do those factors interact in their learning process?

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#### Acknowledgements

We thank the PER group at The OSU for helpful suggestions. This work is supported in part by NSF grant #REC-0087788 and #REC-0126070.

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