# USING DESIGN PEDAGOGY WITH LEGO AND CAD SOFTWARE IN A TASK-BASED ENGLISH AS FOREIGN LANGUAGE TEACHING CONTEXT

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## Abstract

Task-based language teaching (TBLT) has heavily influenced syllabus design, classroom teaching and learner assessment in foreign language teaching contexts (Nunan, 2004; Skehan, 2009). This paper discusses an innovative English as Foreign Language (EFL) undergraduate course, which incorporated task-based assignments, design education, project management and technology-enhanced language learning. In this course, the language learning assignments centered on designing and analyzing objects using CAD software such as Autodesk 123D Design, BuildwithChrome and the Tinkercad. Following real in-class physical LEGO assembly, design software was used collaboratively to develop further design analysis and procedural understanding. Students met both individually and as group activities centered on technical document authoring. Google Drive, and Schoology (learning management system) were used extensively during the course. This paper outlines a task-based technical communication course and explains how students worked on real LEGO design, and then co-authored engineering reports detailing the structural and functional specifications documenting the assembly procedure. The paper also considers how LEGO-based 3D design principles can be taught in an EFL classroom. Students were not only taught design, but also how to author complex technical documents in English. This innovative approach with TBLT involves learner-driven active learning so that hands-on interaction with physical objects takes place before theoretical instructions are provided (Blikstein, 2013). Incorporating collaborative design pedagogies using real (physical) and virtual (online) LEGO design, and DV (digital video) to develop language learning coursework that promotes active learning.

Keywords: computer-aided design (CAD), LEGO, assembly, task-based language learning (TBLL), communication, active learning, technical writing.

## 1 INTRODUCTION

Task-based syllabus design and classroom teaching is increasingly becoming a potent pedagogical strategy in foreign language teaching ([1]; [2]). In many countries around the world such as New Zealand and Vietnam, task-based language teaching has been propagated by national governments as a major pedagogical tool and a favored approach for second and foreign language teaching [3]. Long [4] argued that in many second and foreign language contexts, language was taught in a piecemeal and decontextualized fashion. This approach was argued to be superficial and not reflective of how individuals learn language. A possible solution lies in learning language while solving problems engaged in communicative tasks as in task-based language learning [5].

Some East Asian education systems are gradually adjusting to student populations who can communicate adequately in English, and the syllabi are incorporating principles of communicative language teaching (CLT) and task-based language teaching (TBLT) [6].

Rod Ellis, the pioneer of task-based language teaching, having researched what constitutes a task, concluded that there is no single “task-based teaching” approach (2009). Another important conclusion was that the task-based language teaching approach is not a replacement for traditional form-based language teaching. Both approaches can be implemented jointly [7]. The fundamental principle of task-based language teaching is that a context should be constructed that will nurture the students’ natural language learning ability, rather than an incremental language curriculum. Although the TBLT approach is innovative and progressive, some researchers have criticized the concept of ‘task’ and approach of context-building as invalid constructs around which a foreign language can be taught ([8]; [9]; [10]).

Our view is that tasks in an English as a foreign language-learning context must be constructed to motivate students to complete the project, rather than putting exclusive focus on learning the


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language. Ellis [11] states that for tasks to qualify for a language-learning medium, the focus must be on ‘semantic and pragmatic meaning’, the context should create opportunities and gaps to communicate (convey information, express opinion, infer meaning, etc.), rely on student’s own linguistic and non-linguistic resources, and the outcome must not be the language itself.

This article considers an innovative task-based language teaching approach where a context is built around active learning with LEGO such that hands-on interaction with physical objects in a classroom is encouraged before theoretical instructions are incorporated. This project is an innovative attempt to incorporate collaborative design pedagogies using real and virtual LEGO design so that language learning coursework is developed that includes active learning [12]. We will discuss how using LEGO for design planning and implementation in class facilitates a flipped classroom and active learning approach. In this way, student groups collaborate on creating both real and virtual LEGO products in class, follow design fundamentals in the process, write about the process online in an objective way following document design guidelines, and construct websites employing their own procedural instructions on the product assembly. Data about individual and group assignment scores in the course will provide a summarized description of student performance.

## 2 REVIEW OF THE LITERATURE

An interesting feature of task-based language teaching that is somewhat neglected in the literature is the fact that task comprehension and execution towards an expected outcome requires a relatively thorough understanding of critical reasoning and writing. Lave and Wenger’s [13] notion of situated learning and social constructivism in the product-process framework of L2 writing [14] are central theoretical constructs that can explain how participants think about handling separate projects within a collaborative setting. Presently, most college writing programs emphasize critical thinking in writing classrooms ([15]; [16]). In addition, we will consider the organization of task-based language teaching and how a flipped classroom model might promote critical thinking. The current trend in instructional design is toward a flipped classroom model where the classroom is a setting to work through problems, collaborate in groups, brainstorm concepts, write co-authored documents, peer-review work done for the course, and exchange ideas and plans [17]. The flipped classroom model has been recommended to carry out meaningful learning activities in class, and analyzing the activities toward goal-oriented outcomes [18].

Both the flipped classroom model and active learning through critical reasoning could be more integrated in task-based language teaching (TBLT). TBLT is based on various structural attributes that make it comprehensive and learner-centered. These features are relevance of the task, appropriate level of the task (catering to learner’s current competence level), learning by doing, involvement and motivation [19]. Task-based language teaching (TBLT) approach is gaining popularity in Japan due to its ability to teach language through non-linguistic media, and for promoting language learning in communicative ways. In 1999, the national curriculum in Japan advocated “communication abilities” as the central need in foreign language education [20]. In 2013, MEXT ruled that English language education should emphasize learner-centered activities and grammar as a supplemental tool supporting communication, while deemphasizing translation methods [21]. Blikstein’s model of active learning will help us discuss the integration of physical and screen-based interactive task-based activities in a language classroom.

Most classroom-based problem-solving activities involve some form of analytical thinking that decomposes problems into sub-problems. Research in education and learning has widely accepted that students using LEGO can learn important mathematical and scientific ideas by incorporating actual design activities while learning about design fundamentals [22]. Papert’s [23] research suggested that the use of physical LEGO pieces or online software (LOGO) promotes the development of a constructionist learning/teaching environment that provides children with the possibility of interacting with technology on a number of different levels (concrete to abstract). It is interesting that students often discover they need to learn new knowledge and continuously revise existing knowledge before they can begin solving problems when using LEGO in a project-based learning. The following section discusses a unique task-based language-learning course that offers in-class manufacturing, design education and project management as central characteristics of English language education.

## 3 THE COURSE – METHODS AND APPROACHES

A recent version of an undergraduate English language course titled *Writing and Design with LEGO* was offered to undergraduate (junior) students in a Japanese computer science university. The course was offered to 30 undergraduate students in a flipped classroom and introducing an active learning style. This was an 8-week course in a quarter system. Following a flipped classroom and active learning model, the actual lecture time was limited, and students mostly focused on researching a topic, watching and comprehending a video, communicating continuously in teams, working on CAD or physical LEGO software, and documenting the process as a technical report in Google Drive.

The first week of the course included watching YouTube videos about LEGO including its use and history. Students also viewed televised commercial messages and other videos about LEGO. Next, the students were asked to describe the major points in the videos. They also analyzed a LEGO education website and explained its major purpose as part of open-ended questions.

For the second week of the course, students worked in small groups, read about the fundamentals of product design, answered questions on why they think LEGO could be an effective tool towards designing a product, and analyzed images of LEGO products conjecturing on what they thought to be possible problems when building these units using LEGO blocks. Further, based on the product design stages of analysis, concept and synthesis, they wrote a report on how they would approach the design of a specific product using LEGO blocks. Finally, they searched for Google images to identify a LEGO product that they would rate to be extremely difficult to assemble using LEGO blocks, and explained five (5) reasons why the assembly was construed to be so difficult. Finally, they were asked to reflect on 3 strategies that they would adopt to overcome the construction difficulties. This is an imaginary context, but built around a real-life physical task the completion of which depended on creating semantic and pragmatic meaning, communication opportunities between group members, and using different linguistic and non-linguistic media.

The 3rd week was focused on a LEGO assembly assignment where student groups (mostly groups of 4-5 members) designed a Google Sites webpage and submitted the link in *Schoology* – the learning management system used for the course. Each group had a single webpage and each group had a LEGO toolkit. The first step of the project was to use the LEGO blocks to make a rough physical prototype for a unique design of a product of their choice, based on Internet search. The physical prototype was considered to be the starting prototype. Students then followed clear detailed instructions on how to design each linked page from the homepage of the website. The first linked page introduced the product that the group designed, explained its purpose, authored comments on why they thought the product to be unique with a special design, potential customers of the product, reasons why the product would be enjoyable to use, etc. Further, students were asked to use pictures of the assembled product based on *BuildwithChrome* CAD software. The CAD software was used with the design of the first physical prototype. The second linked page focused on identifying 10 major steps in the assembly process of the product, including pictures of each step. The 3rd and 4th linked page focused exclusively on reporting the problems faced during the assembly both using the physical LEGO blocks and the CAD software, including showing images of the product from different angles. For the 5th linked page, groups were asked to develop the design prototype using *Tinkercad* software.

For the 4th week, students made a 10-slide oral presentation (based on www.slideshare.net) explaining their group project completed for the 3rd week. Students were given very specific guidelines teaching them about the content, organization and layout of the slides for the presentation, including an oral presentation rubric used for the purpose. The 5th week had the midterm exam covering topics and concepts read until the 4th week. During the midterm week students also completed an extensive *Integrated Project Questionnaire*. This questionnaire asked students about the task difficulty when completing the 3rd week assignment, group participation and collaboration, task motivation, peer review of the websites as posted for the 3rd week assignment, etc. The appendix section provided a brief summary of the questionnaire layout as encountered by individual students. Students answered the questionnaire individually.

The Week 6 individual assignment focused on an in-depth design and analysis process. Students were asked to design a complex robotic product using Tinkercad, and then further develop the design and a similar version of the complex robot using BuildwithChrome. The designs with Tinkercad and BuildwithChrome might not be similar, but a more important consideration is the focus on the process and writing about it, rather than the precision of the outcome. Finally, students authored a 10-slide technical PowerPoint presentation about their design based on very specific slide-by-slide guidelines.

Similar to the week 3 presentations, students as part of this individual assignment uploaded their work in www.slideshare.net and submitted the link in S*choology*.

Week 7 was geared more towards concept building and critical reasoning. Students read online articles about LEGO applications, 3D printing techniques, 3D Printing + LEGO for fast prototyping, etc. and were then asked specific open-ended questions from these articles. The questions were more about student opinions about a technical process or business development, and asking them to research concepts such as product usability in the context of LEGO use, etc.

The course ended with a final exam focused on all the concepts, opinions, suggestions about processes and assignments completed during the quarter.

*Assessment*: The assessment for all the assignments in the course was based on 5 major principles.

1 Ability to brainstorm ideas and write about it in understandable English
2 Ability to follow instructions from the assignment
3 Ability to organize documents in a decent way including all content items, layout and formatting
4 Ability to research a topic reasonably well so that it somehow reflects in the document authored
5 Author English sentences and paragraphs without overdependence on translation software

## 4 INITIAL FINDINGS AND OBSERVATIONS

This section provided a summarized overall data of student performance in the course for selected major assignments.

Assignment submissions and in-class observations have shown that students were able to complete the 1st week assignment successfully, based on the instruction guidelines. Data showed high scores for the open-ended reading comprehension questions pertaining to the history of LEGO and research about LEGO use, but the quality of responses for the open-ended questions were lower for the video comprehension questions.

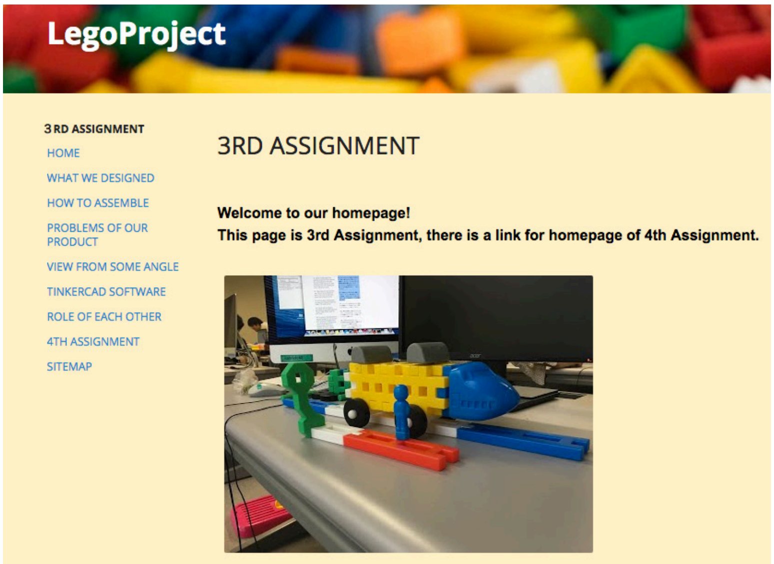


Figure 1. Screenshot of a LEGO Project from a group website.

Figure 1 shows a screenshot example of the product design website assignment completed during the 3rd week assignment.

Students followed the instructions for the week 3 assignment quite well, making the linked pages as expected, and following the design and layout guidelines reasonably well. The assignment score for the groups ranged from 11-15 with 15 being the full points and 13 being the average score. On an average 90% of the group members actively participated in the group assignment with 3/5 groups having one member each who dropped out. For the digital video-based technical presentation assignment, the average score ranged from 3-4 on a 5 scale for the groups. The major problem with the oral technical presentation was with the quality of English sentences in the slides and oral language proficiency. A technical presentation rubric was used to guide the students and grade their presentation.

There was much room for improvement when it came to writing grammatically correct sentences, forming opinions, providing suggestions about a process or explaining a video or process as seen in the YouTube video. It was clear that students had the capacity to form opinions in Japanese, but depended on Google translate to communicate their ideas in English. As the focus of this course is more on the process and continuous assessment, frequent practice and similar assignments focused on improving student writing drafts helped students self-reflect and self-improve the writing process. The idea here is that by following a structure with multiple iterations and/or writing opportunities, students eventually become more proficient writers.

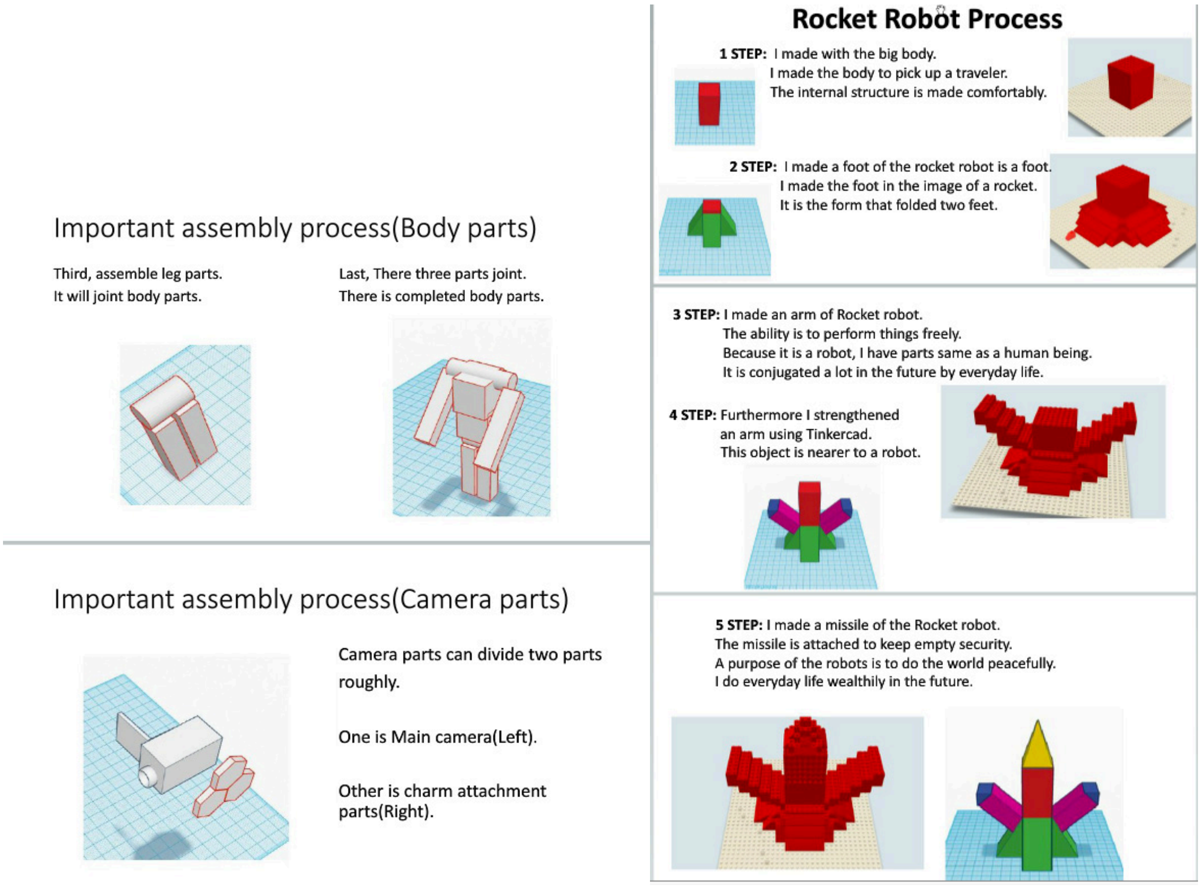


Figure 2. Screenshot of the complex robotic project (Examples from 2 groups).

Figure 2 shows screenshot examples of the complex robotic project as built by individuals (not groups) as part of the week 6 assignment. This assignment demonstrated that students can use the CAD software such as *Tinkercad* and *BuildwithChrome*, and follow the instructions to use the images of their designed products in stages while using a predefined sequence for procedural instructions. Students performed sufficiently well with text-graphics coordination, layout and formatting details in the websites. However, the students did not number the sequences, caption images with text, identify graphical viewpoints, and use headings to explain procedures. Nevertheless, it is possible to develop such documentation skills over time with further clarification of documentary requirements. Furthermore, they needed more time and multiple drafts to gradually improve on the quality of English text used in the slides and in the webpages. The workload probably exceeded student ability to complete within an 8-week course.

Students found the article analysis on 3D Printing and LEGO assignment (week 7) a little difficult at times, as the topics were relatively more specialized and its reading required relatively higher-level reading and comprehension skills. However, the purpose was to allow students more exposure with specialized topics in the field even when comprehension of the English text was difficult. They were encouraged to read the articles and watch the videos multiple times and also use electronic and web dictionaries in the process. Class observation suggested that they referred to websites such as *Wordlio* on a continuous basis, and also read the articles over a prolonged period of time. Many students were observed to be writing the text in Japanese and subsequently using Google Translate. However, even when using machine translation, they were encouraged to use it as a preliminary draft and use their own English language ability for editing. The student score on the assignment ranged from 2-5 with 3 being the average on a scale of 5.

The detailed data from these projects, including student performance and self-reports (based on an extensive questionnaire – see Appendix) about task difficulty, motivation, peer review of the website will be discussed in another article. The overall self-reporting questionnaire data shows readers rate the course project to be reasonably difficult (in a Likert scale) more often, moderately rate their own group performance, have positive emotions about the assignments, the task, the group work, were reasonably strict when rating other group projects, and were comfortable using the CAD and brainstorming software and authoring their own websites. This self-reporting-based perception data will help complement the student performance data for the assignments.

For the above-mentioned assignments, students could form the ideas and use the concepts reasonably well. However, as mentioned earlier, the primary issue was with organizing the information, layout of the design, and most important developing the technical writing skills with good grammatical sense. Since, the idea is to move away from a traditional language learning approach where language structures and fundamentals are fed directly, the task-based language learning approach should be focused on repeated practice sessions where a single document is improved as iterations. Students should be able to self-correct the linguistic deficiencies, but specifically guided about information sequencing and organizing, and that has to come over time and with repeated exposure to language learning situations.

## 5 CONCLUSION

Some of the content that students included when authoring the English websites, writing about LEGO prototyping and design, critical reasoning and comments about a video etc. was satisfactory and acceptable. However, the major language-related deficiency when writing a response for an assignment was more about communicating (translating in English) the existing ideas formed, rather than the idea itself. For weaker students, this process was a good start towards brainstorming and helped develop ideas in Japanese (their native language) as a first step. Improvement is likely to happen with repeat practice in similar writing contexts and sustained exposure to procedural writing with critical and analytical reasoning exercises.

However, in the described learning context not all English language courses are focused on task-based language learning. Courses cover a range of subjects such as phonetics, syntactics, semantics and pragmatics, and TOEIC preparation. The focus of the present course is the procedural design process of a 'task' in the context of task-based language learning. The advantage for students of a design task is the learning technical writing process along with critical reasoning for design tasks, software functionality, and communication with team members. Future course improvements will involve continuous assessment with clear guidelines in the form of rubrics to direct the thinking and document design workflow. This course has introduced a relatively complicated sequence of 'tasks', and each stage in the process takes time to master both in terms of the procedure itself, and to document how it was done. However, the immersion of students in this non-native English language context helped them to develop their English language ability through self-monitored extensive readings, watching videos, researching topics, mastering the use of CAD software, making oral presentations, physical handling and improving on the design and finally authoring the technical documents. Future research should also focus on how each step of the process is completed and how notes are taken to record interaction with the software and physical LEGO blocks. Further, we will study how students organize their group interactions and communications, and how documentation is carried out for various tasks. A usability approach to understanding each software and technical documentation process is important for a technical writing course and we will continue in this direction. Finally, future studies could look into how to teach a similar course with exclusive focus on digital video documentation and oral presentation, or usability testing and research methods.

This TBLT research represents for us a breakthrough in course design where students receive scaffolded guidance in documenting a process that changes the approach to language teaching. We are making a transition in teaching approach based on the expectation that students should be able learn in English when given the appropriate structures and guidance with TBLT.

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## APPENDIX

**As part of the Integrated Project Questionnaire on the class LEGO project (Week 3-4), students were asked to rate their group's performance on the following tasks on a 10-point Likert scale.**

Task # 1: Pictures in the Google Sites webpage demonstrates that the physical LEGO bricks were put together successfully to make a complete product.

Task # 2: The Google Sites webpage has a nicely designed homepage introducing the product that was designed. Pictures of the complete product are shown along with a text explanation.

Task # 3: Separate linked pages were designed for each of the 7 questions as was instructed in the class.

Task # 4: Most of the linked pages were designed nicely with the following:

- Assembly screenshots from BuildwithChrome
- Proper headings, and a title for the linked pages
- Text explanation in short paragraphs
- Nice organization and layout of the webpage

Task # 5: The text explanation in the webpage makes sense grammatically and logically, and were not directly copied based on online translation services such as *Google Translate*.

Task # 6: BuildwithChrome software could be used successfully towards designing the product.

Task # 7: Tinkercad software could be used successfully towards improving the design of the product.

Task # 8: The group worked together successfully, and everyone contributed well.

**Task Perception: As part of this task, students were asked to rate the levels of difficulty with each task on a 7-point Likert scale and another usability scale.**

Task # 1: Putting together the physical LEGO bricks

Task # 2: Making a product design in BuildwithChrome based on the physical LEGO blocks.

Task # 3: Organizing the Google Sites webpage with pictures, screenshots and text.

Task # 4: Developing on the design using Tinkercad software

Task # 5: Completing the project in a group; making the partners work together, group discussions, group participation, group contribution

**Emotion: Please choose the words under each category that best describes your feeling about a particular task. Put a tick mark against your choices.**

1. Class-related emotions 2. Learning-related emotions 3. Assignment-related emotions

______Enjoyment ______ Hope ______ Pride ______ Anger ______ Anxiety ______ Shame ______ Hopelessness ______ Boredom

Write a sentence explaining your learning-related emotions:

**Team Peer Review: This section secured data on the overall assessment of team members on the following topics. A 7-point Likert scale was used for the purpose.**

- Attended project meetings
- Contributed to discussions
- Attempted to communicate clearly
- Listened effectively
- Accepted criticism gracefully
- Completed tasks fully and on time

Another scale was used to identify the word that best signifies the performance of other team members.

| | |
|---|---|
| Excellent | Consistently went above and beyond; tutored teammates, carried more than his or her fair share of the load |
| Very Good | Consistently did what he or she was supposed to do, very well prepared and cooperative |
| Satisfactory | Usually did what he or she was supposed to do, acceptably well prepare and cooperative |
| Ordinary | Often did what he or she was supposed to do, minimally well prepared and cooperative |
| Marginal | Sometimes failed to show up or complete tasks, rarely prepared |
| Deficient | Often failed to show up or complete tasks, rarely prepared |
| Unsatisfactory | consistently failed to show up or complete tasks, unprepared |
| Superficial | Practically no participation |
| No Show | No participation at all |

**Software analysis post-study usability questionnaires were used to rate student's perception of their interaction with BuildwithChrome and IHMC Concept Mapping Software.**

**Website analysis usability questionnaires were used (QUIS, CSUQ, etc.) to rate student perceptions on other groups' performance with website design.**