What do they think when we say ‘learn?’
Children’s conceptions of learning within a design-based environment

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CEP 917: Final Project

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Introduction

One of the most interesting things about the SPLA (hereafter referred to as Space Camp) situation is that it allows us to examine what students really think about what it means to teach and learn science. Specifically, we are afforded a glimpse of what students in a non-traditional class setting (summer, elective, not formally assessed) consider to be the best ways to address science content (the solar system) for the purpose of helping others gain understanding in an engaged, motivated manner (an educational game). This leads to the central research question of this qualitative study. Since “learning” is the explicit purpose of the game being designed, how do the student-designers conceptualize it; what do they think about learning and how it can be facilitated/included within a game environment?

Literature Review

Surprisingly little research has been published on the metacognition of k-12 students directly related to their thoughts on what it means to learn. The few pioneers in this field have mostly focused on how students think in relation to their own learning achievement (as measured by direct, intervention-oriented testing techniques). Though this certainly is a step in the right direction, these studies are more removed from the design oriented situation of Space Camp in that they do not ask students to design experiences for others to learn from – therefore, they do
not expect students to be explicit about what it means to learn in general, as well as for themselves.

Ingrid Pramling has studied what learning to learn looks like in great detail. Her work on children’s conceptions of learning stretches back to the early 1980s, yet they tend toward the pedagogical ramifications of such findings. Her 1990 work, *Learning to Learn*, Pramling conducts a phenomenological experiment based upon preschool children's self-understanding of their own learning, and in it she brings three main considerations to the fore. She makes clear the need to consider children's differing levels of metacognitive awareness, the ways in which children's conceptions of learning can be developed by using their own understanding of learning, and her main assertion that children learn qualitatively different and better (faster) if they are more aware of their own learning. Clearly, the differences in Space Camp participant ages (middle school students from 5th and 8th grades) and those of Pramling’s study can not be ignored, but her results provide a strong case for how such a program is beneficial for the learners engaged in thinking about the design of educational games – requiring them to think about their own understanding of learning in the process.

Alison King (1989) used the “ASK to THINK—TEL WHY®©” model with multiple pairs of students where tutoring was taking place. This model provided students with the cognitive tasks of questioning, problem solving, and explaining, in addition to monitoring learning; her study looked at how these cognitions are distributed across tutoring pairs and found that using this model promoted student creation of new knowledge. Unfortunately, the “tutees” were present and interactive and the model for gauging students’ metacognition was completely provided – much different than the Space Camp situation where the goal was to create such a model in the guise of an educational game for nonspecific end-users. The participants’ awareness of some major contexts between ‘teacher’ and ‘learner’ (cultural and linguistic similarity, for example) is an aspect of King’s work that makes it less applicable to the Space Camp data. Yet, it also raises the question of how children from different cultural backgrounds conceive of learning.

Jin Li, a researcher at Brown University, has framed her career around studying how children in different cultures develop different ideas about knowledge and learning, and how their understanding of learning influences their actual learning behaviors. Her interests have lead her to study children’s conceptions of knowledge, the relationship between children’s thoughts of what their lives are about and the process of learning, and socialization for developing these beliefs. These themes merge nicely with the Space Camp situation, yet the focus of her work is on how the conceptions of children affect *their own* learning behavior, not their conceptions of the learning behavior of others. In some of her latest work (2002), experiments demonstrate how technologically-based design activities empower children from a wide range of backgrounds to become more confident and competent learners themselves, making strong connections with key ideas in mathematics and science. Clearly, this gives good precedence for examining how students might then use the same technology (and their own ideas about what it means to learn) to design experiences that will promote confidence and competence in others.

The collection of studies in Yasmin Kafai and Mitchel Resnick’s (1996a) compilation, *Constructionism in Practice*, follows along the same lines as Li’s work – showing that computational technologies can transform conceptions of learning, education, and knowledge.
The experiments described within the research demonstrate how technology-based design activities can empower children from diverse backgrounds to become more confident and competent learners of mathematics and science. Employing Seymour Papert’s idea of constructionism (1993) as a comprehensive theoretical framework, the book contains articles about learning through design and learning in communities, two topics coincident with the Space Camp study. One study in particular, that of Kafai herself (“Learning design by making games”), is especially helpful in understanding the constructionist framework. She explains that without wanting to deny the value of instructional games, constructionists have focused their efforts providing students with greater opportunities to construct their own games—and to construct new relationships with knowledge in the process (Kafai, 1995). Though such educational games with constructionist approaches have received much less attention than their “instructionist” counterparts, Kafai claims that that they hold far more potential for engaging children’s enthusiasm for learning.

Yet, the research base is not without some warning. Tan and Law (2002) use results from a brief survey to show how students’ conceptions of what is “useful in learning” tends toward what is most like their own classroom experiences. Nearly half of the children surveyed about the usefulness of particular activities in promoting creativity and learning favored the activities that were most like those typically present in their own daily classroom experiences, and, consequently, most like those within the relevant national standards. Hence, any such look at the ways in which students conceptualize and operationalize learning within their designed games needs to consider the likely influences of outside models (Michigan Benchmarks for Science Education, contemporary game designs, etc) as possible explanations for any patterns that arise. In the present study, it is assumed that the influences of classroom, home, and game experiences will be present – the task is to comment on the student-designers’ conception of learning while operating within the effects of these sources.

**Methodological Considerations**

The nature of this study is primarily qualitative, yet it employs a triangulation technique afforded from the sheer mass and variety of data collected in the Space Camp project. The main data sources are the documents provided by the main researchers, consisting of observer notes, photographs of student-generated brainstorm session posters, and presentation materials used by students to inform game designers of their intentions and desires. With the last two groups of data, it is entirely my interpretation of the materials that yields patterns in student conceptions of learning; yet the observer notes are essentially second-hand glances of what was happening during the Camp sessions. Use of the Nvivo software package further complicates matters by having each note coded into prefabricated categories for further analysis. Though this can be a tremendous boon to a researcher in terms of organization and analysis, my lack of familiarity with the original data (I was not part of the project) constantly caused concerns over construct validity – are these categories set up to measure what they purport to measure? It was specifically for this reason that I chose to employ the other two data sources for comparison and triangulation.
The observer notes coded into NVivo were the first group of data analyzed. Though the observers were rigorously cross-checked, the inconsistencies in note taking between groups became problematic. For instance, when identical searches were performed on different groups (even for groups at the same age or grade level) sometimes drastically different results were found – for one group research observers (ROs) made copious notes involving discourse about learning, while other groups had no such comments. When dealing with such a specific research question that does not seem to fit any of the predetermined categories, it is no surprise that such inconsistencies can cause tremendous problems when trying to find patterns in data across multiple groups. For this reason, the unit of analysis can not be specific groups of student-designers or genders (as the participants were grouped by gender), but must remain at the larger, whole-Camp level. Certainly, differences between groups or genders can be commented upon, but any such claims would, in the eyes of this researcher, not be generalizable to any degree beyond the Camp.

It is also very interesting to note that the main purpose of Space Camp was for students to design an educational game. It was explained to students that “the experience they create should teach important science content and should inspire kids to want to study science and to think about careers in space exploration” (ROs Roles, p.4). Therefore, it might be assumed that asking questions around the notion of learning would be facilitated by the coding of the notes. After all, in order to say something about what students are thinking about learning, it is critical to look at the interactions and activities they undertake for hints at their theories of learning (naïve or otherwise). This implies that the “what” of the “design process” will be very important – yet it is precisely here that problems emerge. The design process sub-categories (the “what” and the “how”) have no mention of “learning” or “educational value” in any way. Clearly, the coding was not done with my study in mind! Though this proved to be a hurdle for my investigation, analyzing the intersections of the students’ “interpersonal dialogue” – especially “learning,” “science,” “technology” and “school” – with the coding of activities they engaged in and specific notes regarding them yields a great deal of insight into their conceptions of learning during the Space Camp program. When coupled with the inferences drawn from analyzing the student-generated process and product documents – the brainstorm sessions posters and final PowerPoint presentations of their designs, respectively – a clearer picture of what participants thought of an educational game, and learning in general, will emerge.

Analysis of Observer-Generated Artifacts

Using the pre-coded data and the NVivo software to sort them, a series of searches were performed. For each group, intersections of the “learning” discourses and the nodes for each activity on the camp schedule were mined for useful threads to examine. This produced myriad intersections, only about half of which were truly related to the task at hand (notions of learning). From that point, a cautious examination of the coded documents was undertaken.

When students were asked about the validity of their experiences as opportunities to learn (as dictated in the Space Camp activity schedule), it was most interesting to notice the frequent downplay of simulations as “make believe” (JP20030730) or not “real” (GP20030721), and therefore inadequate learning experiences. In fact, this pattern of valuing real experiences over
what are perceived as fabricated extends through all the groups (and boy groups to a larger extent) in their discussions of activities. This notion of real rather than simulated experiences being somehow better to learn from may extend naturally from the nature of the material being learned (science and technology). In fact, references made to school classes by the student-designers consistently suggest that “hands on” (GP20030721) experiences are appreciated the most in science classrooms. As an example, Leo from Solar System 6 laments how “boring” (AH20030721) her school science class was due to a lack of connection between the real objects and what was presented in class. The importance placed on the realism of experiences is even more intriguing if one considers the perceived factual and concrete nature of the science content to be included in the game.

Students were faced with activities ranging from talks with NASA staff to playing simulations of colonizing Mars. The “facts” and “science” presented as the educational material of the game was decided upon in groups, based around strands of the National Science Education Standards (NSES), and the students spent quite some time talking about it. It is especially interesting to note the highly compartmentalized nature of the facts they selected, and the way in which science is defined by the student-designers. At one point, asked to do just that, Neptune Jihad’s Telescopium suggests that science is “something that has to be proven” (TM20030722), which speaks to the view of science as factual and objectively true. Incidentally, this runs quite counter to the main thrust of inquiry put forth by NSES and other science education documents – yet the process component of the standards was not provided to the students, only the content standards were provided to inspire their considerations.

An important part of identifying something as “educational” lies in one’s ability to verify that learning takes place. However, most of the student-designer groups (and, as a side-note from this author’s experience, most novice teachers) simply substitute assessment for the learning that it purports to measure. In fact, the actual learning of the science content is hardly discussed. Only in one group is there mention of how students come to gain knowledge – all other discussions are focused around measuring knowledge that is (presumably) already there. In order to do this, student-designers (naturally, it seems) fall back on things they know such as multiple choice tests as methods for incorporating “learning,” but with the help of teacher facilitators some are able to break out of that habit. For example, Challenger2 had to rely on their TF to suggest alternatives for their game design. Some student-designers came up with ideas for including aspects of learning (again, mostly assessment of knowledge) that were more embedded within the game, but only slightly so. Octans, from the Frozen Eclipse group, suggests having players “fly to a correct answer” (FD20030728) in order to make progress in the game, yet there is only a subtle distinction between this and simply selecting the answer to a multiple choice question. It is possible that this reflects a perception of ‘learning as assessment’ – yet it could also be seen as evidence for a perception of ‘game as assessment tool’ at work.

Student-designers felt that “kids want… games to be for fun,” and they believe that “learning is what books are for” (Challenger2, GP20030729) so there is no need to make them educational. Many of the Space Camp activities were often referred to as both “fun and a good way to learn” (LR20030723) by student-designers in their discourse; yet, the distinction between what is ‘fun’ and what is ‘educational’ was clearly understood by some. Columba, from the Angel Girls group commented on whether an activity was a good learning experience by saying, “No not
really, just a fun experience” while Indus claimed she “didn’t learn anything [but it] was fun” (LR20030722). This ability to distinguish between fun and educational, and understand how the two might overlap is critical if one is to assume that the student-designers were considering both in their plans.

There was also the realization by many participants that anything related to school-type activities would endanger the fun aspects. Neptune Jihad’s Monoseros suggests that “if you take notes the game can’t be fun” (ET20030722). Clearly, the suggestion of taking notes to learn affects the game’s ability to entertain in his eyes. To further that notion, and explicitly state the difficult nature of their design task, his group mate Hydrus suggests that “most games [in school] are not fun. Kids wait all the year for the summer to get rid of calculation and writing. It would be very hard to create such a game” (ET20030723). This was the impasse for most groups, the realization that fun and educational are not easily wed. It appears that most groups came to this consensus (at least implicitly) and decided to downplay the educational component in favor of fun. If the goal was to make an “educational game,” most student-designers came through the Camp process with a greater focus on the later (game), rather than the former (educational) component of the goal. To buttress this inference, several of the research observers made comments about how groups tended to not mention the “learning aspect of the game” (GP20030731) unless it was explicitly brought up by the teacher facilitators. Considering this was ostensibly the main goal of its creation, it is worth noting the frequently overlooked nature of the educational component. It is also worth noting that variance in the facilitation of different teacher-facilitators (TFs) caused some groups to focus much more on the educational component of the game than others.

As an extension of this notion, “educational” and “fun” are not only seen as separate, mutually exclusive qualities for a computer game, but only by camouflaging the educational component within the fun of a game do several student-designers expect that players will accept it and not “even know they are learning” (MP20030730). This role of “incentive” (ET20030722) was a large topic of discussion for two groups, and was at least addressed in two others. Most of the others discussed the problem of making a fun, yet educational game, but had no overt talk of ‘luring’ players into educational situations. It is important to note that this topic of conversation as an issue of design was encouraged by the “Focus Chats” that asked students to comment upon learning – yet student reactions to these activities show signs of an increasing disinterest in the topic as time passes. Even in these directed activities, however, at no time was there an adult-generated conversation that dealt with the notion of ‘tricking’ players into learning – this seems to be an original idea from within the groups.

**Analysis of Student-Generated Artifacts**

The three-legged stool upon which the conclusions of this study rest is formed not only from the transcripts of Camp activities, but also from the student-generated brainstorm session materials and end presentation materials. By comparing findings from each of these three groups of data, the importance of any emerging patterns (or lack thereof) can be further commented upon with greater confidence.
Due to the guidance of the Space Camp faculty, there was an imposed bias on the actual conversation topics and ‘required’ contents of the presentation. Rather than dismiss these data as tainted, I choose to accept and operate within the confines that restrict them because of the beneficial (and unique) insight they provide. In order to do this, a brief analysis of the Camp materials suggests a five-category analysis framework for both the brainstorm sessions and presentation materials. The five categories – motivation, realism, educational aspects, aesthetic considerations, and relationships – arise out of the types of activities and experiences that students were engaged in, as well as the types of expectations placed on their designs by the adults. Each of these categories is chosen with an eye toward learning (e.g., How do students incorporate motivation in their game, and how important is it in their considerations of learning?). By using a similar framework for both student-generated data sources – and then being able to compare them to the observer notes – pattern consistency can be checked and issues of construct validity lessened.

**Brainstorm Session Materials**

Each group engaged in brainstorming activities during the second week of camp that were focused around specific themes (Science, Navigation, Backstory, etc.) predetermined to be of importance to the game design. Each one of these sessions involved students taking notes and writing ideas on large sheets of paper that were later digitally photographed. Since the participants had spent the first week gaining different experiences, these activities were to provide them with a chance to mine their imaginations for interesting ideas to include in their educational games. By examining the photographs of the brainstorm sessions materials, I hope to find patterns in language and topics that represent what the students think about learning.

As one of the aspects parts of the ‘backstory’ brainstorm, motivation for playing the designed game was written about on each groups’ posters. It is clear that a strong motivation was assumed to be required for those that play the game (and succeed), as most groups suggest invariably complicated circumstances – from globally destructive viruses hatched by evil villains to serious overpopulation dilemmas and the need to make lots of money. The connection between this aspect of the game and the educational component is clear when most groups suggest that “learning” is one of the ‘whys’ and “being on a mission” (Challenger2) is how to keep people playing.

Most groups created a poster full of ideas for their game designs, yet only small portions of them involve ‘educational material’ or “science” and “facts,” as the Challenger2 group called them. The student-designers were instructed to select a few “powerful ideas [from the National Science Education Standards] and teach them very well as part of the game” (Summary of Camp Activities, p.5) during one of the brainstorming sessions. It is interesting to note that the ideas that are labeled as science or facts (or their equivalent in other groups) appear to be notions straight out of textbooks such as “gravity depends on mass and distance” and “earth is the third planet.” This was the norm for all groups, though the older students tended to write more open-ended questions in their brainstorm sessions (e.g., Can there be life on other planets?). The role of the science content in their brainstorms was slight in comparison to other factors, such as the importance of user engagement and interactivity.
All the groups were directed to brainstorm ideas for the players within the game, and it is interesting to note the spectrum of how this topic was entertained. Only one group (Solar System 6) seemed to spend time on the functionality of the game interaction with the actual player – they suggested the use of varying difficulty levels – while several groups restricted this discussion to a simple choice between provided characters or avatars. This is interesting to note, as it suggests that a concern for cognitive level of the end-user was not a high priority for the student-designers. Moreover, very little evidence exists in the male groups for considerations of actual interaction within the game (beyond the physical contact of battle). In fact, Challenger2 made specific reference to having “not much talking” and “not too much dialect” (which I assume to mean ‘dialogue’) in the free-form brainstorm session. Though this seems to play into a pre-conceived stereotype of boys versus girls, the focus on low interpersonal communication and large amounts of (especially physical) conflict in this manner suggests a very different conception of learning at work. That is, if learning was still the underlying goal.

The language that groups use to describe the realism of their designs is quite interesting. From the call for “realistic” that Solar System 6 makes to Frozen Eclipse’s need to “feel like you are in the game,” it is clear that the student-designers are interested in a learning experience that is as real as possible. Most strikingly, though, is the reality of the science content that all groups include (aside from, of course, the extraterrestrial life and interstellar travel capability). Actual planets and distances are discussed, as well as the demands on living off of the planet and questions of technological capacity. There is an urge to be “intellectually honest” (as Bruner might say) about the ‘facts’ that are part of the educational component – a kind of realism that is mildly ironic amidst the outlandish storylines and premises proposed.

**Final Presentation Materials**

The teams of student-designers were responsible for creating and presenting a PowerPoint presentation. The audience was composed of parents, professors and game designers, and the express purpose of this activity was to provide the game designers with the raw material needed to create a draft game intro. That being said, examining the presentations is a great window into student-designers’ conceptions of learning, so by analyzing the presentation artifacts (PowerPoint presentations), I hope to find the campers’ views on the nature of learning within their game. By focusing on the five categories of analysis mentioned above – motivation, realism, educational aspects, aesthetic considerations, and relationships – similarities and differences between the presentations can be examined.

Using many kinds of motivation as a means for encouraging learning is an aspect of education that has existed perhaps as long as the notion of teaching. Student-designers faced motivational strategies within the Space Camp, but the certainly came in with notions of how to motivate learning from their school experiences and home life. It was particularly interesting to look at the ways in which they incorporated motivation into their game designs. Clearly, they find the motivation of the player to be an important aspect of the game. Many groups use incredibly strong motivators within the plot summaries – for example, everyone on earth has a virus for which only you can find a cure – with only two exceptions. Both the Angel Girls (5th grade
girls) and Challenger2 (8th grade boys) groups do not include explicitly disastrous consequences for their players’ failure to succeed, yet they suggest motivations that could be important—finding missing persons and referring to the game as “exciting and challenging,” respectively.

This notion of motivation ties in with the presence of the ‘educational’ aspect of the game. It is important to note that all evidence of explicitly instructional material (where student-designers make reference to it) is highly procedural (simple right/wrong questions that test factual recall), with one exception. The Angel Girls include “training” as a specific aspect of their game—one in which players “learn” how to fly, navigate, and actually play the game. They go on to specify that if you lose the game, you automatically return to training and restart. This cyclic nature reflects a somewhat sophisticated conception of learning as more than a linear walk from ignorance to understanding. Overall, however, student-designers seem to feel that only by embedding procedural tasks within their high-stakes game will players feel the need to complete them, and even then only in a linear fashion that is hierarchical (you can’t progress to the next level until you beat the first level). Four groups refer to the ‘curriculum’ of their game as “trivia” or “facts” that are tested, while the other three groups make no mention of it at all. Only in the cases of the Challenger2 and Desdemona groups is there a stipulation for realism placed on the nature of the learning material. Perhaps because of their age (both are 8th grade groups) they have come to understand the value of learning things that are ‘real’ to them.

The level or realism also intersects with motivation to learn—some would argue the more ‘authentic’ the task, the more likely a learner is to engage with it. Four of the groups are very specific about the game appearing “real” or “realistic” while two groups make no mention of this aspect. The Neptune Jihad group suggests that their game is “based on money”—which might be interpreted as realistic, especially when also considering the high stakes they create for success. The majority of groups found realism to be especially important in their design, and those who do not also have some of the weakest educational content as well as the weakest motivations for players. For example, the group Kalisti makes no mention of realism or educational aspects, and their motivation for players to learn involves some vague and undefined threat.

Instructional design relies heavily on the aesthetics of the material to interest and motivate learners. The ways in which younger students understand this may be subtle and subconscious, but the importance of appearance (both audio and visual) is certainly a theme in the presentations. With several groups including drawings of characters and space ships and others using nearly half their slides to showcase music and sound effects, the student-designers are clearly interested in the aesthetics of their games. Though this could be argued as having little to do with player learning, it is telling to note how the sounds are especially important to the student-designers for the purposes of “exciting” players and maintaining a “suspenseful” feel. Clearly, they are interested in motivating their players, but it is even more intriguing to note that the three groups who are explicit about this aspect of design are also the most specific about the factual/procedural nature of learning tasks. In a sense, it appears that game aesthetics can serve the purpose of motivating players to complete learning tasks that are hauntingly familiar (and boring) to any school child. Perhaps these student-designers have a strong understanding of the “spoonful of sugar” rule when it comes to encouraging the participation and ‘learning’ of others.
In any learning situation, there is interaction – perhaps between two people, a person and a computer, or otherwise. Analysis of the student-designers’ end products suggests that a large rift exists between ‘interactivity’ and ‘interaction.’ By that, I mean to say that most groups include at least a partial discussion of how the player interacts with the game itself (interactivity of the game), but only three teams specifically discuss interactions within the game itself. These groups (Solar System 6, Kalisti, and Desdemona) all suggest the inclusion and importance of “conversations,” “relationships,” and even require (in the case of Kalisti) that players “communicate… and interact” to play the game. Only one of the other five groups brings up a related issue, but Frozen Eclipse’s references to game characters as “moody,” “mysterious,” and “bad tempered” can hardly be seen as on par with Desdemona’s game option of owning a pet “that needs to be taken care of.” It is highly interesting to note that three of the four female groups include relationship/communication/interaction requirements in their game, while none of the male groups include anything beyond suggestions for user interface controls. This may be picked apart for many reasons, but the female groups’ openness to interaction within the games suggests a more sophisticated view of learning.

Discussion

The camp itself seems to have seriously impacted the students’ conceptions of what learning is all about. It is highly likely that the observed conformity in the products presented is related to the initially ambiguous expectations, followed by later specific instructions, from the Camp staff. It is also possible that the confusion among some groups over what needed to be included in the presentation accounts for the lack of focus on the learning aspect of their designs. Yet, the Camp also included some very regular activities where learning was a main focus (focus chats). Oddly enough, the notes reveal increasingly cursory (but regular) attention paid to learning, and the students seem increasingly disengaged from the issue – with the exception of the need to ‘disguise’ the learning in their game. Perhaps the rote, repetitive nature of the “was this a good way to learn” prompts created a dulling effect on their interest or focus on learning. The structure of activities (either too rigid or too flexible) may have a noticeable influence on how students address learning.

Aesthetics was a large part of both the brainstorm activities and the presentations. Clearly, students were interested in the textures, game play, sounds, and overall feel of the games they were designing. Even down to highly specific details, their attention to the aesthetics accounts for a large portion of their time and planning energy. This is by no means a mistake, as it is obviously intertwined with their ideas of learning – the separation of ‘educational’ and ‘fun’ in their words and actions, as well as the expressed need to disguise the learning within the game (and create strong motivations to persist in playing) are clear themes that emerge in all three sources of data. Granted, there was a push for students to think about the aesthetics of their design, but the connection to learning that emerged was not one apparently fostered in the activities or instruction.

Motivation was evident, but mostly for the purpose of engagement in the game – few groups wanted specifically to motivate learning (and even then, it was really assessment being pushed). When you consider the method in which the students were motivated by the Camp staff, more
questions arise about the effect of the students’ experiences on their conceptions of learning. In one of the first activities, the purpose for the game design was explained to the participants. It was explained that “there is a national emergency – the United States has a serious shortage of space scientists” (1-1-1 Event description). As this was part of the initial motivation for the students to participate in the program (presented on the first day), it raises the question of whether the campers were simply following suit when employing incredibly intense situations (e.g., the earth at war, mass annihilation, etc.) as motivation in their games. Coupled with their insistence on presenting science content as either trivia or just facts requiring procedural recognition (and remarking on the similarities this has to their school experience along the way), it seems reasonable to conclude with Tan and Law (2002); students appear to follow the lead of whatever instruction they receive (be it from the guest speakers, videos, or previous school experiences) when it comes to determining what counts as a sound learning activity. This certainly could be further examined by comparing student explanations with those in the NSES or State of Michigan Benchmarks, the foundation of their school science curricula. Also, similarities between their game designs and those of current educational software designers could be compared.

In a similar vein, motivation, education, and aesthetics were three of the main focuses of Space Camp activities, so it is little surprise that these turned out to be the main focuses of the presentations. It is more surprising (and possibly enlightening) that the presence of relationships (interaction within the game) and the realism of the designs were such large parts of the student-designers’ presentations. Yet, given the context (an intensive community-based environment) and the focus on concrete experiences with technology, these findings are not completely unexpected. What is unexpected are the strong connections that students made between these categories and the idea of learning – some of which may be related to the organization of Space Camp, and some of which may be relics of previous experience. Either way, the games that students seemed to be designing were strongly “constructionist” (as per Kafai’s description) with regards to the aesthetics and game play, yet tended toward “instructionist” strategies where the science content was involved. This dichotomous split is highly informative, as it supports the strong separation of education and fun that seemed to permeate all the data.

**Conclusion**

One thing that every researcher must ask as they organize and carry studies is whether or not what they measure reflects the larger construct they are examining. No construct as complicated as conceptions of learning can be measured without some proxy – and it is up to the researcher to make a rhetorical case for why this proxy will work. In this case, the proxies for students’ conceptions of learning are the language they use regarding the topic (via the artifacts they generated and notes made by trained observers) and the design choices they make, up to and including the final presentations of their work. These are reasonable methods for estimating their conceptions of learning, but there is one catch. Students were told at the beginning that the purpose of the game was educational, and this study banks on that fact; yet the direction that the activities take (mostly focused on the design of aesthetics and story) and the lack of importance placed on ‘learning’ in the coding of the original data seem to suggest that this purpose was not so central after all. The results indicate that the students mostly felt the same about the learning-
related components of their games. Whether these two trends are merely coincidental remains to be seen, but it is worthy of noting that, in an attempt to shine a light on students’ conceptions of learning, this study has effectively become a warning beacon to educators of all creeds. Be careful of the ways in which you teach, for they likely will shape the ways in which students believe they can learn.
List of Works Cited and Consulted


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