

# Pre-service Teachers' Perceptions of Web-based Interactive Media: Three Different Tools One Learning Goal

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**Abstract:** Web-based interactive media offers, new possibilities to teach and learn. These new possibilities place a greater emphasis on technology integration for in-service and pre-service teachers. In addition, researchers identify the need to investigate teachers' perception about incorporating rich media into their classrooms, because they are ultimately the catalyst for technology integration. Therefore, the purpose of this study is to investigate how web-based interactive media is perceived and experienced by pre-service teachers. Identifying what they notice and value as important can provide strong indicators of how visible the pedagogical intent of the designer is. If these intentions are not apparent then teachers will either not select them or use them with the full desired intent. Nor will they see the alternative potential of the interactive media. A phenomenographical study research design was developed to describe teachers' perceptions about technology. The participants included 224 pre-service teachers from an introductory educational computing course. Participants were assigned to one of three online tools designed to convey concepts of size and scale. The paper describes what participants define from each tool as instructional activities, instructional methods, and instructional media and what they considered the advantages and obstacles for incorporating those into their classrooms.

## Introduction

Web-based interactive media provide new possibilities to teach and learn. Hypermedia or rich media offers advantages for teaching and learning in the form of interactive experience that provide instant feedback, multimodal presentation of information, intelligent guidance to facilitate sense making, and access anytime and anywhere. The combination of rich media and user control of how to access that media has been defined as instructional media that incorporate high-end media types such as, video, sound, and instructional methods such as simulation, animation, and so on with the goal to help people learn in computer-based environments (Newby et al, 2006 ;Clark & Mayer, 2007).

These advantages should place a greater emphasis on technology integration for in-service and pre-service teachers' training (Ottenbreit-Leftwich, 2007). They are going to be the ones who will guide and facilitate their students' learning process with the technology. Part of understanding how to assist teachers to adopt technologies for learning requires knowing what teachers think about incorporating rich media into their classrooms (Srinivasan & Crooks, 2005). Srinivasan and Crooks questioned the reasons why it is so difficult for teachers to adopt technology into their pedagogical approach. Among other reasons, they pointed out teachers' perceptions such as the lack of evidence that technology would make their work more interesting and effective. Therefore, the purpose of this study is to investigate how three different web-based interactive media are perceived and experienced by pre-service teachers. In order to address this purpose, a phenomenographical study was developed to address the research questions: *What are pre-service teachers' perceptions of web-based interactive media for teaching size and scale related concepts? What are the key characteristics of the media that make it more advantageous for their students? What are possible obstacles that would inhibit students' learning?*

This study explores these questions by identifying what participants define from a specific web-based interactive tool as instructional activities, instructional methods, and instructional media. Also, what they considered the advantages and obstacles are for incorporating that tool into their classrooms. According to Newby, Stepich, Lehman and Russell (2006), instructional activities present content during lessons to help students learn specific learning goals. Instructional methods refer to formats, procedures or actions used to help students achieve the learning goals. Instructional media is the way the content and methods will be delivered. The participants in this study are part of an introductory computing course where they learn about educational technology. The goals of this course are for students to demonstrate their ability to use computer systems and apply them to enhance their own professional growth and productivity. They will also be able to apply technology to support instruction their area of

specialization. This research may provide technology developers with a stronger foundation from which to design interactive media for instructional purposes and will promote among educators the thoughtful adoption of technology into their classrooms.

## Methods

A phenomenographical approach was used as a qualitative method of inquiry. This approach has been employed to describe and analyze perceptions and experiences in educational settings (Marton, 1981). By using phenomenography, we sought to identify how pre-service teachers' experienced the online tools. According to Marton, "phenomenography is the empirical study of the limited number of qualitatively different ways in which various phenomena in, an aspects of, the world around us are experienced, conceptualized, understood, perceived, and apprehended" (4424). Therefore, the main outcomes from this phenomenographic study are "categories of description" and the distribution of participants' responses over them (Marton, 1994); while the first result is qualitative in nature, the second is a quantitative one (Marton, 1981).

## Procedures

The study used web-based interactive media targeting learning goals associated with comprehending concepts associated with size and scale. Concepts related to size and scale of different objects, are difficult to comprehend. For example, researchers found that the general public is unable to identify the relative sizes between micrometer-sized and nanometer-sized objects (Edu.Inc, n.d., 2004, 2005; Holladay 2005; Jones et al. 2004; Waldron, 2006). Edu.Inc identified that their interviewees have limited knowledge and consistent misconceptions about atoms, molecules, DNA, cells, and other things unobservable with the unaided eye (Edu.Inc, n.d.); misconceptions such as the smallest thing that they can think of is something they can actually see (early elementary students) or objects at the microscopic scale (Holladay, 2005).

Three online tools designed to convey the selected concepts were used for this study. All three can be classified as multimedia interactive tools that provide visual and text based information (audio is only background music which is considered incidental to the learning outcomes). The users control navigation with the mouse to access various visual images of objects and text descriptions of the objects. Each tool contained two main components: a) set of objects in different sizes and b) a logarithmic scale indicating the actual size of the object.

The first web-based tool, Generation Nano GN (Network for Computational Nanotechnology, 2007), is a Flash animation serious game designed for learning about various aspects of nanotechnology including size and scale. As part of the first activity users can explore objects from the atomic to macroscale. The activity compares the size of objects along a scale from the nanoscale to the macro scale. The scale is represented in powers of 10 and is the main interactive interface for the users (See Figure 1). Other activities included in the GN website related to size and scale comprise having students: a) compute their height in nanometers, b) learn the rules of the game in which by use of analogies students compare macroscale objects to micro and/or nanoscale objects, and c) sort objects in a scale according to their sizes (see Figure 2).

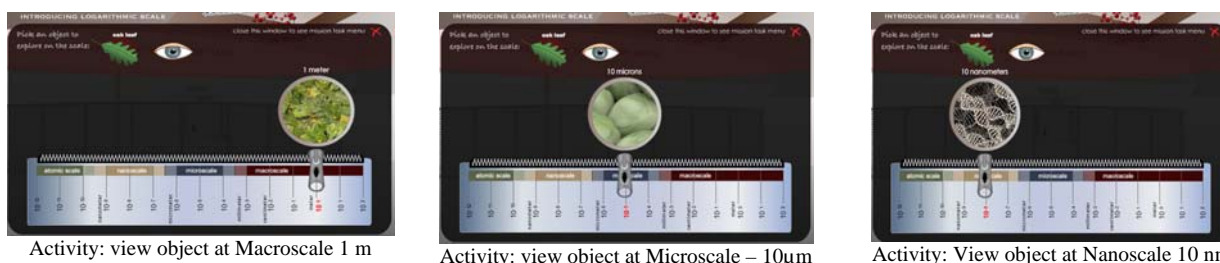


Figure 1 – Generation nano's interactive activities associated with comparing size of part of objects



Activity: measure yourself in nanometers



Activity: Learning the rules of the game



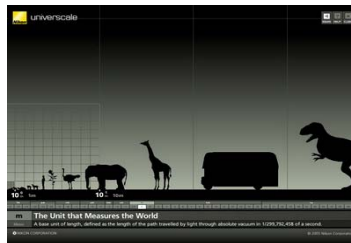
Activity: sorting objects on the scale

Figure 2 – Generation nano's interactive activities related to learning size and scale concepts

The second web-based tool called Universcale (US) (Nikon, 2008) is a Flash animation that compares the size of objects from the nanoscale to the universe scale. By clicking on the scale the user can rapidly index a text description of objects on the scale and see images of objects in that scale range (See Figure 3). The third web-based tool, called NanoScaling (NS) (Playgen, 2009), uses a similar approach of comparing relative sizes of objects as the Universcale, but also contains 3D graphical images of objects next to each other. Again, a scale provides a frame of reference for the objects and a navigation mechanism to index various sizes of objects along the scale. Users can also click on the objects to obtain more information (See Figure 4). One note is the NanoScaling is an executable program that needs to be downloaded before it can be executed. The other applications can be executed in a web browser.



Feature: introductory information to the scale



Feature: comparing objects in the scale

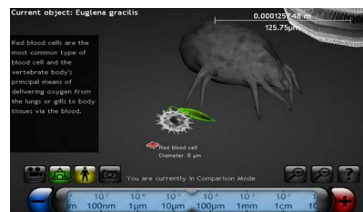


Feature: Additional information per object

Figure 3 – Interactive features of Universcale



Feature: Comparison mode



Feature: Popup text with information



Feature: Character mode

Figure 4 – Interactive features of NanoScaling

Prior to interacting with one of these web-based interactive tools, the participants were asked to complete a pre-test targeting concepts of size and scale. The pretest targets their ability to categorize objects by scale, identify quantities of scale and the proportional relationship of objects along a scale. Participants were randomly assigned to one of three treatment groups. Participants were given twenty minutes to interact with one of the instructional medial tools assigned to their group. Finally, they completed post-test similar to the pre-test and an online questionnaire. The online questionnaire targeted contained questions about their perceptions and experiences with the tool. Analysis and results from the pre-test are reported in a separate publication. This paper presents the results from the online questionnaire.

## Participants

The participants of the study included 224 pre-service teachers in an introductory educational computing course at a large Midwestern university. The goals of this course are for students to demonstrate the ability to use computer systems and programs and apply them to enhance their own professional growth and productivity as well

as to apply them to support instruction in their selected developmental and content areas. Sixteen laboratory sessions were randomly assigned to one of three different instructional media tools. As a result, there were 74 students who used the GN tool, 93 students who used the US tool, and 57 students who interacted with the NS tool.

We assume all of the participants have similar backgrounds in using instructional technology because the course is at the introductory level. Further, we assume teachers have similar backgrounds in science education. Therefore, members of each of the groups are equally representative of the entire population of learners in the course.

### **Data Instrument and Collection**

According to Booth (1997) interviewing participants is the most common and dominant method of discovery, however, alternative methods could be applied including written responses (Marton 1994). Therefore, written responses to an online questionnaire were used as the data collection method. These written responses of participants' reflection on their experience explore size and scale with a particular web-based tool. The online questionnaire consisted of a set of three questions focused on asking participants to identify: a) the type of instructional activity, instructional method, and instructional media used, b) obstacles they might encounter if they attempted to incorporate this kind of technology in their classroom, and c) characteristics and/or advantages of the application that would help their students understand the content.

### **Data Analysis**

The data analysis contains a quantitative and qualitative component. We conducted an inductive analysis of participants' descriptions of their experiences and perceptions of the web-based tool, following Marton's (1997) guidelines. We started the analysis by applying the systematic procedures suggested by Strauss and Corbin (as cited in Patton, 2002) to code the data. We first describe each of the online tools by means of the categories of descriptions provided by the participants. For each of the tools, we also present the categories of description of what the pre-service teachers considered are the advantages and obstacles for incorporating them into their teaching. We accompany our discussion with excerpts from the participants' responses as well as with our interpretation. Finally for each of the online tools we also report the frequencies of each category of description identified by the participants.

### **Results and Interpretation**

The purpose of this study was to identify pre-service teachers' perceptions of: 1) the interactive media used in three different web-based applications designed for teaching size and scale related concepts, 2) the key characteristics of the media that make it more advantageous for their own students and 3) possible obstacles that would inhibit students learning when using the tools.

**GN-Generation-nano.** Many of the participants agreed that GN is an interactive game that incorporates informational and motivational media. Its most salient characteristics are the use of visuals, audio, text, and animation. Some other students identified it as a type of drill and practice application because of the use of testing and feedback. The most important advantage identified by the participants was its highly engaging and interesting nature. By means of interaction in the form of practice and feedback it was also identified as a tool which advantages may result in learning and understanding. Considering the pedagogy, the participants identified as a very useful instructional strategy the use of analogies to relate unfamiliar objects with familiar ones together with the use of the scale.

*They can work with the scale and re-do the games and activities if they needed to. I also think it is an effective way to get use to the different sizes of things, because there is no real-life way to help them grasp that.*

*This will help them understand it better because it is in a media form they use almost every day. They are able to see the things they are learning and compare them to things they already know about. Making it a game is also helpful for them. This causes the students to want to do better so they can get the prize.*

*I think all the pictures and examples would really help the students see exactly what the differences are. Having the scale and letting the students place where the objects should go can really show it in a different perspective. I think the application is really neat.*

Few participants pointed out that the application had no clear directions and that prior knowledge is required in order to attain learning and/or comprehension of the concepts. The biggest disadvantage pointed out by the participants was the possibility of not having internet access or enough computers for all students.

*I thought this was very advanced, because it was difficult to learn the sizes of the objects. This is a very advanced topic for even someone my age; therefore I found it very difficult to incorporate this. I did like the game aspect as a secret agent type, but on this particular topic, it was too advanced.*

*This program is one way of good teaching tool, but I think that to grasp more concrete concept of size and scale, more instruction is needed. Also, some classrooms may not have computers and that will block the opportunity of using this program.*

**US – Universcale.** According to the participants, US is an informational and interactive application that uses pictures, text, audio, and video to convey the learning goal. The main advantage of this tool, according to the participants, is that, along with the use of the scale, it allows users to make comparisons and to identify relationships of objects of different sizes. An inherent advantage of this application is that it is online; therefore the availability and access are two of its main advantages. Of great advantage for helping students in their understanding and learning is the use of animation and pictures. Also a useful characteristic was that the application was interactive making it somewhat engaging and interesting.

*For students who are computer savvy, having this program online would be very beneficial. They would love working on the computer to complete this assignment. Also, the use of the images keeps viewers entertained. They enjoy seeing different pictures come across the screen. The realistic size comparisons are also interesting. It gives you a real life comparison.*

*With this application it was nice that it could be accessed online and could be used by anyone anywhere. The transition of going from one scale to the next was pretty cool as well as a little bit of information about each of the objects that were used to relate to that scale. Using all these within the application help the users understand the size and scale concept.*

Obvious obstacles identified by the participants are the possibility of students getting distracted with other online websites and the problem of access. Participants pointed out that probably there might not be enough computers available or no internet access. Other possible obstacles identified by the participants were the complexity of the interface that might result in students being overwhelmed, bored, or a general loss of interest. Part of the problem was the excessive amount of text and also that there were no clear directions. Also participants identified that students should have some prior knowledge in order to keep students' interest as well as the need to provide teacher's scaffolds.

*It would be hard for the students to pay attention to one thing at a time. It is very difficult to keep focused on one part and not jump to another. The images move very fast and the student's attention span would be lost very quickly. It would be hard for teachers to try to teach about the different objects if the students were looking at other things while they were talking.*

*One would probably encounter some sort of confusion because the website is so in depth and creative, that all of the action that is going on almost makes the whole thing confusing to a learner. It was, at times, confusing to me, and I'm a lot older than the people who would be learning this information are.*

**NS-NanoScaling.** NS was considered by the participants as an interactive and somewhat motivational game that was composed of mostly visuals, text, and animation. As an online application, the participants agreed that availability and access were two of the most important advantages. The main advantage of this application, according to the participants, was that it allowed users to make interactive size comparisons with familiar objects.

Participants also commented that the animations provided were very useful and the application was very easy to understand and navigate.

*The animation is neat and the fun for students to use. It is very engaging and grabs the interest of the student as well. Students can learn easily without much effort, or even realizing that they are learning. The application feels like a game. It is also very visual which is good for visual learners.*

*Advantages of this application can help the students better understand the concepts. The pictures were a great thing to use side by side in order for the child to see how big or small something was in relation to things around it. Different angles were also used to view the object in order for the specific child to get the best picture possible.*

However participants thought the application was not very engaging resulting in possible boredom or loss of interest. The biggest identified disadvantage was the possibility of not having enough computers and/or internet access. In relation to usability, some of the participants also identified that the application was not very user friendly and the directions were not clear enough. Some students pointed out that prior knowledge was required to enable students' learning and comprehension and very few participants pointed out the need of teacher's scaffold.

*The obstacle that someone might encounter is that the students may not know how to use it or what it is for. When I was working with the program, I didn't really understand the purpose of the program. There needs to be some type of worksheet or something that goes with it to bring the activity and online interaction together.*

*This type of technology would be difficult to incorporate in the classroom due to the inability to keep students focused and understand the true purpose of the activity. Many students might get confused and not understand what they are doing. Also there might be technical difficulties that you encounter by depending on the internet.*

For a summary and distribution of the frequencies in the categories of description identified by the participants in relation with the interactive media see Figure 5. For a summary and distribution of the categories of descriptions related to the advantages of the tool see Figure 6. Finally, for a summary and distribution of the categories of description identifying potential obstacles of incorporating the tools see Figure 7.

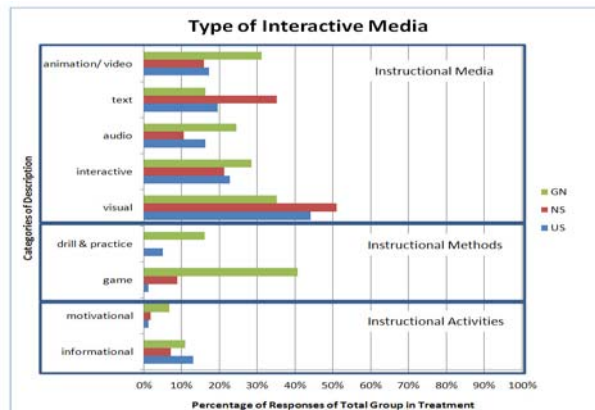


Figure 5. Characteristics of interactive media described by participants

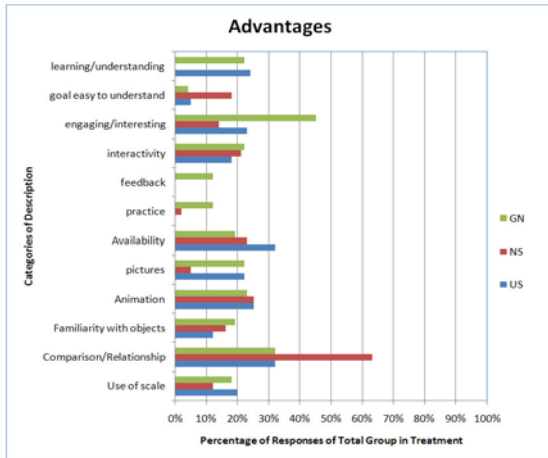


Figure 6. Potential advantages for incorporating the tools

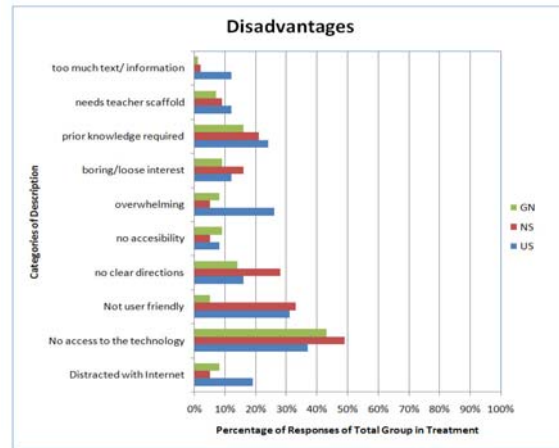


Figure 7. Potential obstacles for incorporating the tools

## Discussion

Looking closer at these results we can derive interesting observations. First, most of the participants identified the pedagogical benefit of using the scale and the comparison of familiar objects with unfamiliar ones. From Figure 6 we can notice that the most frequently identified categories relate to issues of effective pedagogical approaches (comparing and contrasting ideas) and focus on effective learning outcomes (learning with understanding) for the case of GN and US. However, for many participants these characteristics of the tool were NOT perceived from their first interactions with the tools. Therefore, pre-service teachers not selecting these categories as part of their evaluation are possibly less likely to perceive these tools, and potentially other multimedia tools, as useful instructional interventions they could use in their teaching. This is not a statement of the quality of the tool for learning; it is a reflection of the likelihood that a pre-service teacher would select these types of interactive media for instruction in their classroom.

The teachers noticed a number of disadvantages to these multimedia tools that may be beneficial to designers of interactive media tools for educational purposes. From the US tool, we can identify there was much text and the user interface was not very friendly. The participants thought this may result in students becoming overwhelmed. We believe one reason could be due to students' cognitive overload (Clark & Mayer, 2007). For the NS tool, participants did not identify learning or comprehension as a possible advantage of the tool. On the contrary, even though it was the easiest to understand participants did not perceive it as interesting or engaging. What are possible explanations for this discrepancy? We think there are two possible explanations. One could be because of the negative effects of what Garner, Brown, Sanders, & Menke (as cited in Clark & Mayer, 2007) called seductive details. Seductive details were referred to by Garner and his colleagues as information inserted into instructional materials that were intended to arouse interest. In this particular case, the seductive details could be the 3D graphics incorporated in the application. The second possible explanation is related to what Kalyuga, Ayres, Chandler, et al., (as cited in Clark & Mayer, 2007) referred to as the expertise reversal effect. This effect happens when the integration of media such as pictures or text is used in order to help low-knowledge learners. However this may result in interference to the highly advanced learners.

Finally, for the case of the GN web-based tool participants identified it as a type of game instructional method. Participants also identified the two most salient advantages of this tool as: a) one of the most engaging and b) one that by incorporating it in their teaching would possibly result in students' learning and/or understanding. Therefore, we can say that for the GN web-based tool it was incorporated a cognitive source of motivation, which as different from the seductive details, it included an instructional strategy that helped the learners not only enjoy the experience but understand it (Harp and Mayer, 2007). In this particular case the cognitive source of motivation was implemented by the use of analogies as well as the practice and feedback provided by the tool.

## Conclusions

The results of this investigation indicate what pre-service teachers considered relevant when evaluating web-based instructional media into their instruction methods. For some of the teachers the most prominent characteristics relate to pedagogical issues associated with goals for learning and mechanisms for learning with particular technologies. However, for many teachers these aspects of teaching and learning were not readily apparent in their evaluation of the technologies utility for instruction. This is not saying the tools do not have the potential for achieving powerful learning goals. It is an indicator that the teachers may not see the value of these tools in their classroom learning environment. This could be a design consideration designers should take into account. The decision they have made may target some goals well, such as motivation to engage, but lose the impact on potential learning opportunities. Achieving a balance between features and function is an important outcome. Based on a comparison of three tools, the Generation Nano tool may have the most potential for illustrating the potential for learning by balancing user interest (instructional activities), with pedagogical approaches (instructional methods) and goals for learning with understanding and effective use of types of media (instructional media). The careful balance of these principles can lead to effective interactive media.

This study provides an important perspective on how teachers perceive online interactive media. We believe a follow-on study that asked participants to compare and contrast these tools would provide a stronger indication of their perceptions for learning with the tools. Further, this compare and contrast activity can be an excellent instructional activity in the course for how to effectively evaluate instructional media relative to specific evaluation criteria.

In summary, when incorporating hypermedia or rich media into learning experiences, design consideration should not only include factors associated with the practical, motivational, and educational advantages, but also the potential challenges pointed out by Clark and Mayer. These challenges include students' cognitive overload, the expertise reversal effect, and the negative effect of seductive details in interactive games. Data is being analyzed further to identify which of the three web-based instructional media was the most effective (if any) in conveying concepts related to size and scale of different objects.

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