Using Promethean Technology to Create a Math Unit

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Abstract

With technology continually changing the world of education, it is imperative for current and future teachers to have a strong knowledge of educational technology in order to create more engaging and effective lessons. The author, an elementary teacher, taught himself how to use a Promethean interactive whiteboard, and its accompanying software, ActivInspire, in order to create a self-contained unit plan on fractions. Using evidence-based principles for creating effective educational technology, and national standards for 3^{rd} grade mathematics, the unit plan was created. The project encompassed seven distinct lessons, each following a similar format with the focus of increasing student engagement and interaction compared to traditional lessons. The project's effectiveness on learning is unknown, due to the fact that the author is currently not teaching and had no access to a third grade class. Once the project is properly implemented and data can be collected, future steps will be determined, with the understanding that the project is a starting point for future endeavors to effectively use interactive whiteboard technology.

Keywords: educational technology, interactive whiteboards, constructivist learning

Introduction

Whether in terms of access to knowledge or how information is delivered, education has always been affected by technology. Unlike in previous generations, current technology is forcing education to make changes at a much faster pace. Newer, more powerful technologies have given people more access to more information than ever before. Books no longer need to be printed on paper, and classes no longer have to convene in one location. The way information is being disseminated is in the process of being changed. Students are being exposed to and using technology in almost every facet of their lives, particularly out of school. The challenge for educators is how to effectively bring and use technology in the classroom in a way that promotes learning rather than just being a “cool” or “fun” activity.

One popular, and effective, educational technology that has been implemented in classrooms around the world is interactive white boards. The technology enables users to write like they would on a normal blackboard or whiteboard, but then manipulate what was just written in ways that are impossible to do with traditional tools. The technology is just one of many that has changed how instructors deliver lessons and how students interact with the material.

Since the technology is being used in many districts around the United States, it is vital that current and potential classroom teachers know how to appropriately and effectively use interactive whiteboard technology so that lessons are more engaging and interactive for students. This paper will discuss how the author taught himself how to use a Promethean interactive whiteboard and its accompanying software, ActivInspire, in order to create a self-contained elementary math unit plan.

Background

When the author decided to leave the teaching world to get a Master’s degree in educational technology, it was with the goal of learning about and utilizing current and future technologies that would positively impact future teaching. Though many technologies were discussed, one technology that was not taught was interactive whiteboard technology. When it was realized that the technology would not be presented in any class, the author decided to teach himself how to use a Promethean board and the ActiveInspire software, with the goal of creating a viable lesson or unit.

After much deliberation, it was determined that the overall goal of the project would be to create a math unit that was based on national educational standards and was free from the use of any textbooks. The idea was to create lessons that not only had information on the topic(s) being taught, but to also have built-in examples and questions that engaged the entire class. Unlike textbooks or even other types of presentation software (i.e. PowerPoint or Prezi), ActivInspire was made to be completely editable when used with a Promethean Board, meaning that objects can be moved and the instructor can make notes on the slides, with the ability to save or discard the changes made in class. This ability enables the instructor to make changes to prewritten lessons on the fly, giving them the option to change the pace and/or level of instruction on an as-needed basis. These changes can also be saved as newer or different versions of the original file, allowing teachers to build a library of lessons on the same topic that they can call upon in future years, all without the clutter of paper. Freeing a teacher from the constraints of textbooks and paper-based lessons, not only gives them complete control over what they are teaching, but also enables them to mold their lessons to respond to the specific needs of their students.

The author also hoped to incorporate the main ideals of constructivist learning theory into the unit, specifically within the activities. However, in designing the unit, there was a notion that this would be more difficult to incorporate within the actual lessons due to the fact that constructivist learning typically requires hands-on participation from each student. Unfortunately, the Promethean Board, alone, does not allow for this to occur in a class setting. Thus, the goal was altered, with the decision to use the learning theory as the foundation of how the information within the unit would be presented, rather than try to create constructivist activities that were based within the software.

Research

Tutorials

Having the goals outlined and a good idea of what the approach would be, research was conducted. Initial research began by using a free version of the ActivIspire software that was downloaded to a personal computer, in order to complete a few basic tutorials on the software. However, it was soon realized that the version of the software lacked many tools and capabilities that would not only be important to learn, but necessary to fully complete the tutorials. Without sufficient and available funds to purchase a complete version of the software, it was deemed no longer feasible to conduct research on a personal computer. All research was thus conducted in a computer lab that had both a complete version of the ActivInspire software and a Promethean board. Though this allowed for simultaneous interaction with the hardware and software, it also constrained how much time could be spent on research.

The aforementioned basic tutorials that familiarized the layout and tools of the software were once again utilized, and eventually completed. After the basic functionalities of the technology were mastered, it was decided to explore some of the more complex and powerful tools. A second issue was encountered when it was found that the user must pay a fee in order to look at and go through the tutorials from the Promethean website that explained the more complex tools and functions of the software. An Internet search was conducted, and it was found that Youtube.com had a plethora of videos that not only showed how to use the different tools, but also how they could be applied to different subjects and for different age groups. Since actual teachers and instructors who used the technology on a daily basis created all of the videos, it meant that the methods and approaches taught were viable. By watching videos of how to use the technology, and then immediately being able to try the approaches presented on the software and the Promethean board, a more complete understanding of the tools and capabilities of the technology was achieved.

Evidence-Based Research

While research on the technology was being conducted, there was concurrent research being done on how to create an effective technology-based lesson through the concepts presented in the book *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*, by Ruth C. Clark and Richard E. Mayer. This book focuses on how learning technologies should be constructed using seven evidence-based principles. Though the book was mainly geared towards individuals working on training programs in the private sector, every principle has a strong educational foundation. Even with this fact, it was necessary to determine which principles were most applicable not only for a traditional classroom setting, but also for the project that was to be created.

The book presents seven principles on how to create effective instructional technologies, but only four were deemed usable for the creation of the project under discussion in this paper. The first applicable principle is the multimedia principle, which says that it is much more effective to use words and graphics together on a display rather than just words. The authors state that displaying both pictures and words "can encourage learners to engage in active learning…by mentally making connections between the pictorial and verbal representations" (Clark and Mayer 2011). While words are a great and efficient way to get ideas across, having a pictorial representation alongside words helps solidify the concept that is being conveyed. Of course, it is necessary that the picture is relevant, having a direct connection to the information, rather than being an aesthetic novelty, which can detract from learning instead of enhancing it.

The second usable principle is the contiguity principle, which says that words should be aligned with relevant and corresponding graphics. The reason behind this is that the "psychological advantage of integrating text and graphic results from a reduced need to search for which parts of a graphic correspond to which words, thereby allowing the user to devote limited cognitive resources to understand the materials" (Clark and Mayer 2011). In other words, it is easier for people to make real connections between text and graphics if they are located near each other. This may seem like it is common sense, but it is still something that is incredibly important to maintain. The principle can be divided into two parts. The first part says that printed text should be placed near corresponding pictures, while the second part says that it is important to synchronize spoken words (or audio) with corresponding graphics. While the first part is fairly obvious, the second part is as or more important in terms of the project. Since the teacher who uses the unit plan will be the source "audio" in each of the lessons, it is important that what they discuss pertains to what is on the screen, especially in terms of what graphics are present. Discussing topics that have nothing to do with the information that is being viewed may delay student understanding of the material.

The third principle that could be directly applied to the project is the coherence principle. This principle states that it is important to leave out any audio, visuals, and text that is extraneous to the project. What this means is that any sounds, pictures, or words that do not have a direct connection to the material being taught should be excluded from the presentation/lesson. In terms of audio, the book states that "background music and sounds may overload working memory," while extraneous graphics may cause the learner to have a hard time making sense of the material by being "distractive and disruptive to the learning process" (Clark and Mayer 2011). The same can be said in regards to lengthy texts. While the book is looking at this principle in terms of a learning module, the applicability of it to an ActivInspire flipchart is just as high. Having sounds and pictures that are "fun" may get students to pay attention to the screen, but they may not get them engaged in the lesson. The key is to bring in fun graphics and sounds that can be used to reinforce the ideas and material being presented, by getting the attention of students and then bringing them into the material.

The final principle that is valid for the project is the segmenting and pretraining principles (technically two principles grouped together). The segmenting principle applies the idea that topics with a lot of information should be broken down into smaller, easier to manage sections, while the pretraining principle says that key words and characteristics should be viewed before the topic they are tied to is presented. Since the presentation is essentially a slideshow, the segmenting principle is inherent in the software. The pretraining principle, however, is something that must be applied with this program. Since the lessons are geared for young students, the amount of information would have to be such that it did not overwhelm students before they even broached the subject material.

Given that research in both areas was done concurrently, it was easy to envision how the principles would be applied to the project and what tools would be necessary to apply them. Thus, brainstorming for the project occurred before any concrete planning began. Once all research was finally completed, and most necessary tools were mastered, planning for the proposed lessons began.

Planning

Knowing that this project was going to be a unit plan on fractions, certain concerns needed to be addressed before moving forward. First, the grade level to gear the material toward needed to be determined. Based on the author's previous teaching experience, the project would focus on 3^{rd} grade concepts. Then, a decision on what math standards to use as guidelines for the material in the project, national or state, was needed. Since the ultimate goal was to create a unit plan that could be implemented in a future class, it was necessary to make sure the standards used would be widely applicable, and thus it was decided that using national standards would be the safest bet for the needs of the project.

The specific standards that were used came from the Common Core State Standards Initiative (2011). This is a state-led initiative to have all states base their core curriculum on the same standards, with the ultimate goal of having the same material taught to the same age groups across the United States. Since 45 of the 50 states have adopted these standards, they were a reasonable and appropriate set to use. The specific standards can be seen in Figure 1. Once the standards were obtained, the next step was to move on to planning and outlining each topic, and specifying exactly what to do for each slide within those topics.

Order of Topics

The standards are explicit in what needs to be taught, but unlike a typical textbook or planning guide the specific topics are not as explicitly written out. Based on a review of the standards, it is easy to see that there are three main objectives. First, students must understand what a fraction is, how it is written, and what it represents. Second, students must be able to understand that fractions can be located on number lines and show this understanding by locating and writing them on a number line. Third, students must be able to explain simple equivalent fractions and compare fractions, in general. Within each of these main foci, there are other objectives that focus on different aspects of those main objectives. Those more detailed objectives would be the guidelines for each individual lesson.

Number and Operations—Fractions[5] **3.NF**

Develop understanding of fractions as numbers.

1. Understand a fraction 1/*b* as the quantity formed by 1 part when a whole is partitioned into *b* equal parts; understand a fraction *a*/*b* as the quantity formed by *a* parts of size 1/*b*.
2. Understand a fraction as a number on the number line; represent fractions on a number line diagram.
   a. Represent a fraction 1/*b* on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into *b* equal parts. Recognize that each part has size 1/*b* and that the endpoint of the part based at 0 locates the number 1/*b* on the number line.
   b. Represent a fraction *a*/*b* on a number line diagram by marking off *a* lengths 1/*b* from 0. Recognize that the resulting interval has size *a*/*b* and that its endpoint locates the number *a*/*b* on the number line.
3. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.
   a. Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line.
   b. Recognize and generate simple equivalent fractions, e.g., 1/2 = 2/4, 4/6 = 2/3). Explain why the fractions are equivalent, e.g., by using a visual fraction model.
   c. Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers. *Examples: Express 3 in the form 3 = 3/1; recognize that 6/1 = 6; locate 4/4 and 1 at the same point of a number line diagram.*
   d. Compare two fractions with the same numerator or the same denominator by reasoning about their size. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.l

Figure 1 (Common Core State Standards Initiative 2011)

Though it is not always necessary to teach topics in the order they are laid out in standards or curricula, in this case it was imperative that the first objective was covered first. The reason is that for students to be able to do anything with fractions, whether it is ordering them, comparing them, or visually representing them, they must have a solid and unwavering understanding of what fractions are. Though it is likely that 3rd graders have been exposed to simple fractions (e.g. 1/2 or 1/4), it would not hinder, but more likely enhance their understanding of fractions by teaching the basics of fractions.

Thus, the first lesson in this project would be going over the parts of fractions and understanding the definition of all of the terms discussed, both verbally and graphically. The first idea that must be examined is what a fraction is and how it can be represented. Without this, there is no way to continue teaching the unit, because the idea of "What is a fraction?" is the foundation of the entire unit. Once the idea of "fraction" is understood, the next step would be to break down the parts of a fraction, specifically the numerator and the denominator. This is probably the most crucial point of any unit on fractions, because discerning between denominators and numerators, and understanding what they represent, allow students to extrapolate on their basic knowledge of fractions. With this being the case, it would be important to make sure all ideas and terms were fully understood, meaning that this lesson would need to be carefully planned and constructed, essentially implementing the segmenting principle to the fullest extent.

Once this foundation of knowledge was laid, the next step was to build on it in the most logical way. Though the core standards have fractions on a number line directly after teaching the basics of fractions, it seemed that going in that direction would be too big of a jump for students. However, after much deliberation, as well as consultation with other teachers, it was determined that the next lesson would be on locating and placing fractions on a number line, a tool that students will have previously used when learning about number theory. By this time in the unit, the students should have a decent understanding of what fractions are and how they can be represented visually in different ways. Learning how to place fractions on a number line allows students to actually see the relationship between fractions and whole numbers in a way they are already comfortable seeing numbers. Real world examples, such as rulers, could be used to enhance student understanding by connecting their background knowledge to the concept being taught, even if used only briefly.

The next concept that would be discussed would be on how fractions can be equivalent to each other. The reasoning for this was that if students were able to draw and visually describe fractions, they could learn how to see equivalent fractions in those representations, if they existed. The standards are expecting students to identify simple equivalencies (e.g. 2/4 = 1/2) and not asking them to reduce using division. This is where the magic of the interactive whiteboard technology can really enhance learning, because you can create and manipulate graphics that can show how equivalencies can be true by the simple push of a button, or in this case a "pen," something that virtually impossible with traditional teaching materials.

However, the overall topic of equivalent fractions also includes having students understand how whole numbers can be written as fractions, as well as identifying when a fraction represents one whole. Due to this reality, it was necessary to decide which of those subtopics, whole numbers as fractions or equivalent fractions, should be taught first. Again, due to the nature of how the material was going to be presented, which is mainly visual, the topic that seemed to easily build on the first two lessons would be whole numbers as fractions, which would be followed by a lesson on equivalent fractions. The simple explanation behind this decision was that if students were asked to understand how fractions are parts of wholes, it would be easier for them to see and understand what happens when all of the parts of the whole are "filled up." This would also get them thinking about how fractions can be viewed and written in different ways, which would make the transition easier to discussing how two fractions that may look different are actually equal to each other.

To further enhance the understanding of equivalent fractions, the next lesson would incorporate the idea of equivalent fractions on a number line. This would combine the concepts taught in the first number line lesson and the previous lesson on equivalent fractions. Again, real world examples would be incorporated (e.g. rulers, measuring cups) because they not only utilize number lines, but also are excellent examples of how equivalent fractions are used in every day life.

The final concept of the unit to be taught would be on comparing fractions. As described in the standards, this incorporates comparing fractions with like denominators, as well as fractions with like numerators. Before getting into these concepts, it would be necessary to briefly reteach what the different comparison signs (i.e. <, >, =) mean and when they should be used. From there, the decision of which type of comparison to teach first was easy to make. Comparing fractions with like denominators would be taught first, because comparing objects of similar size and value is a much easier concept to grasp than comparing objects of different or varying size and value. Comparing fractions with like numerators would also require a more in-depth discussion on denominators. So, discussing fractions with like denominators first would make teaching the idea of comparing fractions, in general, much easier to grasp. This would then enable the transition from looking at graphics (that are the same shape and size) that are broken into the same sized pieces to looking at graphics that are broken into different sized pieces a little easier on the learner, since there would be less cognitive load for the students to handle.

After these final two lessons, all of the of topics that were written out in the core standards would be covered. A unit review and a unit assessment would follow the culmination of the unit, though neither are currently a part of the project, though it is possible they may be added in future iterations.

Lesson Format

Having an idea of what would be taught, and in what order, the next step in the design of the unit plan was to actually develop and construct each individual lesson for the unit. Though the idea of the project was to create a self-contained unit with lessons that were more engaging and interactive than typical daily lessons, the lessons themselves could still be setup in a traditional manner. The basic setup would have the format of introduction/ activator, whole group lesson, small group activity, and wrap-up. While this type of setup is fairly structured, it would still be important to keep the framework flexible allowing for the instructor to truly utilize the technology.

An introduction, or activator, would open each lesson. The goal would be to have the students start thinking about the type of information they are about to learn by connecting previous knowledge or experiences to the topic. This may be simply asking, “Have you ever heard of the word ‘fraction’? If so, where?” or asking an open ended question that requires some investigation. Whether discussed as a class or in small groups, the question must have the ability to start a discussion that leads directly into the lesson that is about to begin.

The lesson that follows would be a whole group lesson, similar to a typical lecture format. However, though the instructor would deliver the information, the lessons would not be completely teacher-centered. Students would be asked several questions within the lesson to see if they could come up with the information themselves, which would then be verified by the teacher. Once enough material was presented that students should be able to grasp the concept, questions would be presented to the entire class, which would be discussed and answered as a class. These questions are geared for student participation, where they would be asked to come up to the board to show and support their thought process, which would then allow for the other students to see what they did and hopefully engage in a discussion about what was done.

Once the questions were answered, the small group activity would be presented. Since it is impossible, at this time, to gauge what type of technology would be available to each individual student, the activities are paper and/or manipulative based. This would ensure that an activity that reinforces the material could be done. However, the technology would be used as a timekeeper, a possible check-in (when done), and also to go over answers, having students come up to the board, like what was previously discussed.

The wrap-up would be a quick and simple closing that reiterates what was already taught. This could be a discussion on main ideas, or a quick assessment to gauge understanding. Unlike traditional teaching technologies, the ActivInspire software gives the ability to copy and paste text and graphics, so the same material that was used earlier in the lesson can be shown again at the end. By seeing the same thing that they saw previously, there is a higher chance that students will remember the material that was presented, in the future.

Within this basic framework, there would be informal assessments to gauge where the level of understanding is for individual students and the class, as a whole, at that point in the lesson. This would enable the instructor to take note on what material needed to be retaught and to whom. Since the nature of the software allows for the ability to go back through material that was previously presented, teachers have easy access to what has already been taught, affording them the ability to reteach and reinforce the material whenever they need. The software gives the instructor the ability to give planned assessments, using the Questions feature, or unplanned assessments, using the ExpressPoll feature (though both features can only be used when clickers are available to the class). Questions can also be changed or added, allowing for tremendous flexibility, especially if the same lesson is used for different leveled classes.

Something that needs to be noted is the fact that during the creation of these lessons there was an assumption that the instructor will not strictly adhere to what is written for each lesson. In other words, there is a hope that the material that is given for each lesson will be a jumping point for discussions, and that the instructor will gear the lesson towards the class they have. This could mean having students come up for each slide to show a line of thinking, or moving items around and making notes on the slides to reinforce a point. The lessons are constructed to provide the information that needs to be taught. How that information is ultimately delivered should be dependent on the individual instructor, and not only what is provided in theses lessons.

Overall these lessons, and the unit as a whole, were constructed with the intent to deliver material on fractions that all 3rd graders should know. While they were built based on a standard lesson format, each lesson was developed to allow for lots of flexibility, in terms of information delivery, without jeopardizing learning. It is ultimately up to the instructor to gauge how the material should be taught, but the goal was to give them a basic lesson plan to start.

Results

In the end, the unit plan consisted of seven lessons that covered all of the material the Common Core State Standards (2011) determined were necessary for 3rd graders to learn about fractions. As mentioned earlier, the lessons were ordered in a way that the material would build upon the previous lesson. While this was not completed with 100% accuracy, the final result was fairly close. The final order of the lessons was Intro to Fractions", Fractions on a Number Line, More Fractions – Whole Numbers as Fractions, Equivalent Fractions, Equivalent Fractions on a Number Line, Comparing Fractions with Like Denominators, and Comparing Fractions with Like Numerators. No comprehensive unit review/wrap-up or final assessment was included in the unit.

All lessons incorporated the multimedia, contiguity, coherence, and segmenting principles to the fullest extent, while some lessons incorporated the pretraining principle, based on the work of Clark and Mayer (2011). Though the pretraining principle was actively applied less often than the others, the underlying idea of exposing students to words and ideas before the lesson was used in the development of the order of lessons. Constructivist ideals were also infused in every possible way, though the technology that was used does not afford the ability for true constructivism to be implemented.

Though the full capability of the ActivInspire software was not implemented during the development of the unit plan, the tools and features that were ones used were ones that were mastered and deemed the most appropriate for the lessons. Those tools enabled the lessons to have the capability to be more engaging for students.

Discussions

While not everything that was initially planned or hoped for was able to come to fruition, the project met the overall goals that were set from the beginning. The lessons cover all of the material that was deemed necessary by the Common Core State Standards (2011), but in a much more engaging way, for both instructors and students, than a typical lecture/textbook based format. Students have more opportunity to directly engage and interact with the material that is presented. Instructors have an easier ability to recall material or revise how it is presented, which enables them to alter how lessons, and the information that they present, are delivered based on specific class needs. If needed, instructors could even give copies of the lessons to students to refer to when doing individual work or homework. In reality, the unit is much more flexible and alterable than a standard textbook based lesson, opening a lot more pathways for students to truly understand the material.

These thoughts and feelings, however, are all based on assumptions, though ones based on background knowledge, research-based findings, and experience. Since the unit plan was not applied to a current 3^{rd} grade mathematics class, the lessons' true effectiveness is unknown. Yet, if the lessons are not as effective as it is assumed they will be, it would be extremely easy to alter them in order to increase their effectiveness. That, in itself, is a major advantage when using the ActivInspire software. Hopefully, the results that are envisioned will come to fruition when the unit plan is finally used in a class.

As mentioned in the Results section, the full potential of the Promethean board and ActivInspire software was never realized within this project, and most of the tools and capabilities that were implemented are some of the more basic/standard ones that are used by instructors. There were several reasons that some of the more intricate tools were not used, with the main ones being time and resource availability. Being that the technology and software were both self-learned, and most resources and tutorials were culled from free Internet sources, the ability to truly master the software within a few months was unlikely, especially when the only usable technology was not accessible on a consistent basis. Current teachers who were consulted during the development of this project expressed how much they learned from training sessions on Promethean technology, and that they would be surprised if the technology was mastered in such a short time frame with no real guidance.

Future versions of the project will be based on the success and reactions of students from full implementation into the classroom, as well as future understanding and mastering of the technology as a whole. Thus, it is currently hard to say exactly what would need to be changed. However, one aspect that would be minimized would be the amount of text on each slide. While the text that is supplied is there mainly to be a guideline for instructors, once the teacher knows what they are going to discuss for each slide the text may become a distraction or deterrent for student engagement and/or take up too much room on each slide.

Another goal would be to continually aim to make each lesson more student-centered. This goes right along with trying to minimize the amount of text on the screen, because the words that are supplied come from the teacher, and not the students. In order for students to truly construct knowledge, the words that are used in class must come from the students. From there, the teacher can guide students to come up with answers and understandings of the material based on what they already understand. This would also require more interaction between the students and the material, which means, for Promethean technology, students need to interact with the board more often.

Conclusion

Teaching one's self a new technology is typically not an easy task, and in the case of an educational technology, one must not only learn how each tool within the technology works, but they must also learn how to manipulate those tools in order to effectively teach subject material. This all comes from experiences, and from each experience something new will be learned, and thus the technology can be mastered just a bit more. Educators must allow themselves to be continual, flexible learners, since there are always new ideas, methods, and technologies that will allow them to more effectively reach their students. They must also allow themselves to make mistakes when mastering these new skills, because those are the moments when the most is learned.

There is no doubt that this project can be greatly improved upon, which means there is still a lot of the Promethean technology that can be learned and mastered. However, like most new endeavors, this entire process was just the start of a continual learning experience, and when you start at the very beginning you can only move forward. Once the project is actually implemented and used in a classroom, the next step can be determined. The key is to keep an open mind and be ready to make changes. The technology may never be completely mastered, but if it is understood well enough to engage students and actively promote learning, then that may be enough.

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