PrepChain

A blockchain solution to the problem of tutoring logs

Monique Dargis

9 DEC 2019

SEIS 785 - Blockchain

I. The Problem of Tutoring Logs

Each year, millions of high school students take standardized college entrance exams, primarily the ACT and SAT, and report their scores as a key part of their college admission applications. A large portion of these students will utilize test preparation services that aim to help students improve their ACT or SAT scores via classroom instruction and private tutoring. The test preparation industry is valued at over $1 billion, and students may be charged several hundred or even thousands of dollars per hour for prep services.[1]

With such large monetary investments, parents and students ideally want the services of a tutor with a proven track record who has helped many students achieve their test prep goals. Such proof can be hard to provide, however, when test scores are private information that many students are reluctant to share with the world. Parents and students often must either take a tutor's word for the efficacy of the service or look for testimonials from students – testimonials that may leave out important details such as the student's own level of engagement with the test prep curriculum.

On the flip side, any good tutor knows that the content and strategies they teach are only one part of a student's journey to an improved test score. Even more important is the student's drive to complete the test prep curriculum fully – by doing every homework assignment and practice test, by engaging with the material, and by showing up prepared for every scheduled tutoring session. A student who lacks drive is less likely to improve their score, no matter how many hours are spent with the tutor. As a kind of insurance policy against parents upset that a student's scores haven't improved as much as was desired, many tutors keep logs of homework completion and sessions a student attended. However, this log often isn't shared unless a problem arises, and a parent or student looking for a refund could easily challenge the accuracy of the log.

A final issue facing students and tutors in the standardized test preparation arena is cancellation of scores. The companies that administer the SAT and ACT may cancel a student's scores if there is reason to believe those scores are compromised. This sometimes leads to the cancellation of dozens of student scores when scoring irregularities affect entire testing centers, but more commonly a

[1] https://www.marketwatch.com/story/some-wealthy-parents-are-dropping-up-to-10000-on-sat-test-prep-for-their-kids-2019-06-21

single student or small group of students is accused of dishonesty. Testing companies use predictive algorithms to detect anomalies in scores, including on the individual student level by comparing a student's score with previous official test scores. If a student achieves a score that is much higher than what the testing company's algorithm says is likely, the testing company may flag the higher score due to suspicion of cheating.

Score flagging poses a problem for students who see excellent results from tutoring services – improving their score too much may raise suspicion for the testing company. Once a student's score has been flagged, the only way for a student to 'prove' that they did not cheat is to retake the test and achieve a similarly high score. If the retake is successful, the flagged score stands; if not, the flagged score is canceled. This often takes place months after the student has completed a test prep regimen, and the chances of performing at a very high level are much lower than when the student was practicing daily. Even if a tutor can show via practice tests that a student had been scoring highly due to preparation services, that student's score may still be flagged and ultimately canceled. This may have devastating effects on a student's education – they may lose scholarship opportunities or even admission to some universities due to a canceled score, and cancelations often come after the possibility of applying to additional schools has passed.

II. PrepChain – A Blockchain Solution

PrepChain, a semi-public blockchain, can be used to log a student's progress through a test preparation curriculum, and this blockchain can provide 'proof of effort' in a variety of scenarios.

When joining PrepChain, tutors and students will be given public keys that are a hash of an email address plus a PIN/Passphrase (ex student@gstudent.com1234567890). When a tutor wants to log some activity that a student has taken – for example, the student attended a one-hour tutoring session – the tutor sends that "transaction" to the student's public key. See Figure 1 for a visual representation of a transaction posted to PrepChain by a tutor.

Over time, the tutor's public key becomes an immutable record of all the work they have completed with all of their students, easily accessible by anyone with the tutor's email plus PIN, without revealing any student's identity. Potential tutoring clients (students and their parents) could be given the tutor's email plus PIN to check PrepChain for all the work a tutor has done with previous clients. This could help potential clients select a tutor that gets proven results while maintaining the privacy of that tutor's prior clients.

Additionally, a student's public key becomes a record of that student's progress through a test preparation curriculum. By providing parents with immutable logs of the student's progression through the test prep curriculum that are date-stamped and verified, the tutor can show whether the student truly put in the effort required to improve a score. As an added bonus, students who stop working with a tutor but want to access information about their test prep plan could still easily do so. Students could also have all of their test prep work under one public key, even if they switch tutors, so long as all tutors use PrepChain.

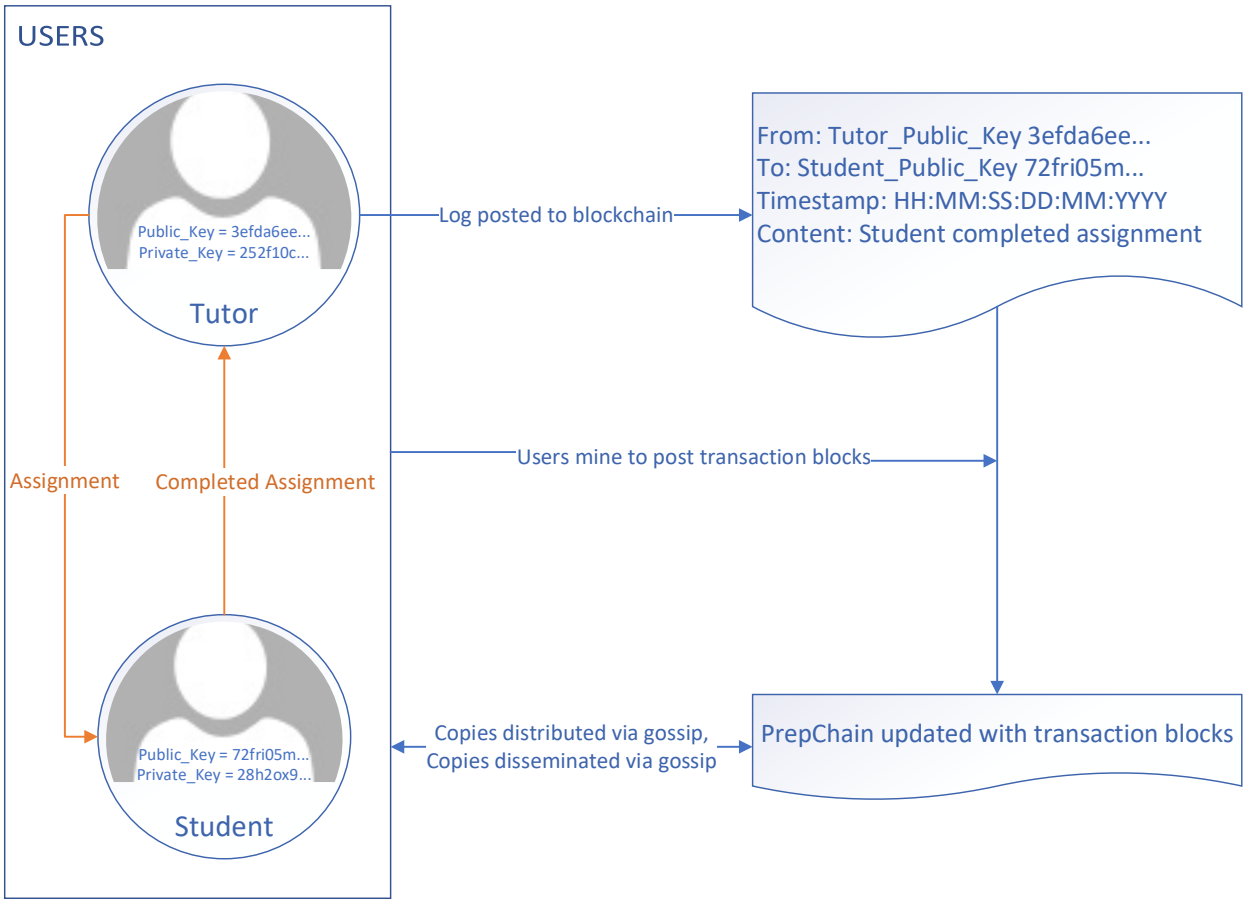

Figure 1 - Tutor use case

Finally, a public blockchain record that can't be altered after the fact could serve as proof of effort in the case of a challenged test score. Testing companies could hash a student's email and PIN to verify that postings to that public key on PrepChain are attributed to a particular student. A log of completed preparation before a flagged test could be given as enough proof to verify that a student's much higher score was not due to cheating but instead due to that student's hard work.

III. Implementation

Public keys will be created using the SHA256 hashing function to hash a user's email plus PIN. Users will also receive private keys that they can use to send "transactions" (aka logs or comments) to another user's public key. Although students may use their private keys to send reviews to a tutor's public key, or to keep their own logs on the blockchain, tutors will be the primary users of private keys as they log student progress throughout the test prep curriculum.

In addition, tutors or students may post hashed pictures or documents to the blockchain. Since most test prep occurs via paper and pencil, records of a student's practice documents are often stored as an image. By logging a hash of that image data on the blockchain, users can later prove that the image is unaltered from the document that was posted on PrepChain. An image hashing

function like dHash[2] could be used for this purpose. Storing images of completed practice tests will be of particular importance for a use case in which a testing company wants to verify that a student is capable of achieving a flagged score.

PrepChain software will need to be downloaded by any person wanting to send transactions through the blockchain. Blocks of transactions will be posted using solutions to SHA256 hash function problems, in a 'proof of work' manner similar to many cryptocurrencies (including Bitcoin). Because there are no monetary rewards for mining blocks, users who wish to participate in the blockchain will be required to mine for a certain amount of time (determined by an algorithm based on the volume of transactions) in order to have their own transactions processed. Users may also be rewarded for running full nodes of the block chain by having that activity count toward the amount of time they need to mine in order to have transactions processed.

Two of the primary purposes of PrepChain – proof of a tutor's efficacy in the eyes of potential clients and proof of a student's prep curriculum to parents and testing companies – involve users who have no need to download or install the PrepChain software as those users would not need to post transactions to the blockchain. Instead, non-transactional users could access the information they need via a block explorer, so long as they have the email address and PIN/passphrase of the user whose transaction history they wish to check. It will be essential that PrepChain have a robust and reliable block explorer for this purpose. See Figure 2 for a visual representation of a non-transactional user use case.

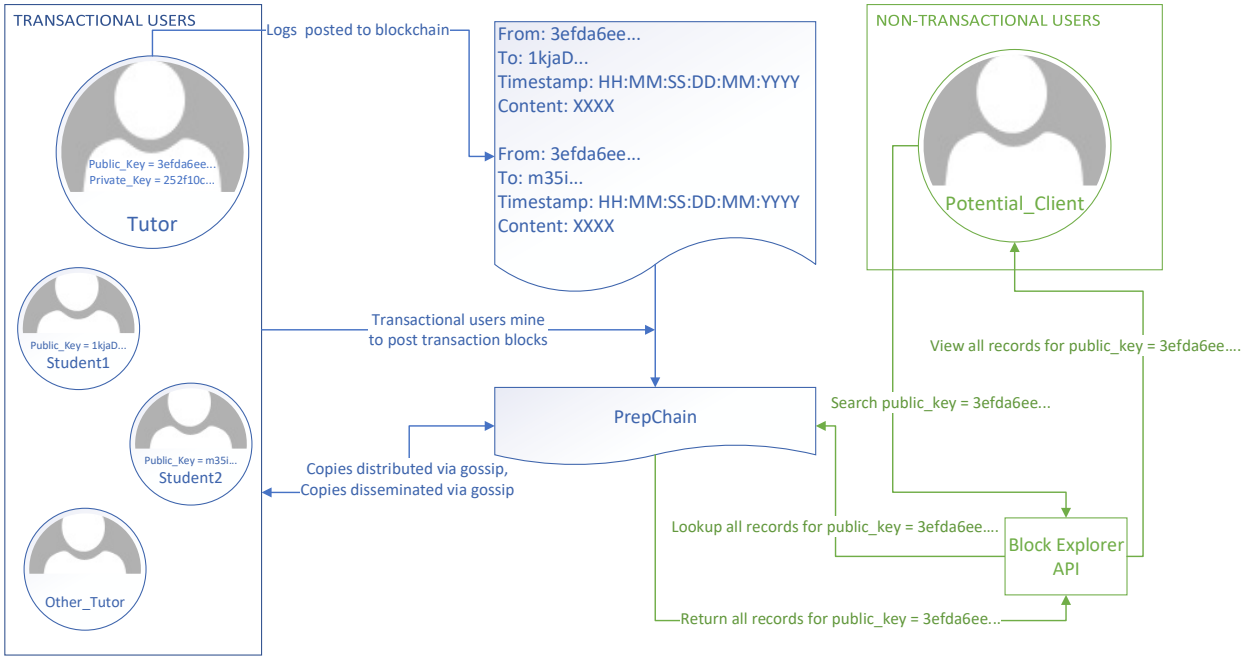

Figure 2 - Non-Transactional User use case

[2] http://www.hackerfactor.com/blog/index.php?/archives/529-Kind-of-Like-That.html

IV. Adoption

The vast majority of regular users of the software are likely to be tutors, as students and parents have short-lived engagement with test prep – they aren't likely to revisit PrepChain after a test prep curriculum is completed unless they need to use the blockchain as proof of effort when a student's score is flagged for review by a testing agency.

As a former test prep tutor and teacher who has worked with students of many abilities, nationalities, and financial means, I am uniquely qualified to implement this blockchain solution. I understand the challenges that tutors and students face in the test prep world. Additionally, I still have many contacts in the test prep world. To get PrepChain off the ground, I would focus efforts on getting buy-in from the large national test prep companies like Princeton Review (where I was initially trained and worked for six years), Manhattan Prep, PrepScholar, and Magoosh. These companies have hundreds, or sometimes thousands, of tutors working for them – a partnership with even one company would provide the volume of users needed to get the blockchain operational.

With no direct financial incentive, it less likely that any group would want to coordinate a 51% attack. However, if tutors employed by any one large testing company were to dominate the blockchain, that company could potentially manipulate the blockchain to make its tutors look better and other tutors look worse. To prevent such an attack, it will be essential that independent tutors also utilize PrepChain. There are many international, national, and regional test preparation and college counselor organizations full of independent tutors. I would work with leadership of these organizations to promote PrepChain to as wide an audience as possible, and I would not launch the software until I felt confident there was an appropriate balance of users between employees of test prep companies and independent tutors.

Convincing the administrators of the SAT and ACT to accept PrepChain as proof of effort in the case of flagged test score is likely to be the most challenging hurdle to overcome. The College Board (which owns the SAT) and ACT, Inc take a somewhat antagonistic view toward students when it comes to flagged scores, as evidenced by their retake-as-proof-of-effort policy. Additionally, both companies have only recently admitted that test preparation can lead to increased scores. The College Board and ACT, Inc now partner with Khan Academy and Kaplan, respectively, as preferred test prep providers. Getting buy-in from these two test prep companies will be a crucial first step in establishing relationships with College Board and ACT, Inc. However, it will also be important to demonstrate the immutability of the blockchain, which is why I would not pursue a partnership with these two companies until after other companies and independent tutors have adopted PrepChain.

Ideally, adoption of PrepChain would be so widespread that logging a student's progress using the software becomes an essential service offered by test preparation tutors. Eventually, students and parents will have the expectation that tutors use this service, and will choose a tutor based primarily on the tutor's efficacy as demonstrated on PrepChain's block explorer.

V. Maintenance

Although test preparation is a lucrative industry, the College Board and ACT, Inc are both non-profit organizations (in name if not in practice), and the goal of using standardized testing to open educational opportunities to those who might not otherwise be able to access them is not an ignoble one. Rather than squeeze a few more cents out of already stretched parents and students, or out of the tutors whose participation is vital to PrepChain's implementation and survival, PrepChain will offer services free of charge. PrepChain will be established as a non-profit organization for as long as it takes to get the blockchain off the ground and lobby adoption by prep and testing companies, allowing the organization to apply for education and technology grants. Once the blockchain is robust and launch bugs have been worked out, the next phase of implementation will be to cede control of maintenance of the blockchain to the users. Users will then be able to propose and adopt changes to the software in much the same way as users of cryptocurrencies like Bitcoin. This step cannot take place until we are confident that PrepChain will not be dominated by the tutors of any one company.