Enigma Academy

Courses, Examinations and Verifiable Certificates inside a Messenger

technical architecture

IAIC TECHNICAL REPORTS

IAIC-TR-2026-04 • November 2026

https://doi.org/10.66693/iaic.tr.2026.4

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Abstract

Enigma Academy is the learning layer of the Enigma messenger: courses for school and university subjects that run inside chats, assessment that is checked by the machine wherever a machine can decide and by a named examiner where it cannot, and certificates that anyone can verify without trusting the platform. A course is an application on the messenger's application interface, in the manner of messenger bots with inline buttons. The interface is general: any other service can be built on it, and courses are its first use. Problems are generated from templates whose answers a computer algebra system computes, so every variant is checked automatically and every learner receives fresh problems; artificial intelligence explains and hints within the learner's plan, and never awards a result on its own.

The report specifies the roles; the application interface; courses, problem templates and the checking modes; examinations, recorded attempts and video answers reviewed by examiners; three levels of certificate; the learner's personal record chain, its daily commitment to the Enigma Root and the Root's anchor in Bitcoin; presentation of a certificate signed with the learner's key, with no name of a learner or an examiner written on any chain; protection of minors and the data policy; plans and limits; security; and the implementation status. No coin, token or fee on the chain is involved.

Keywords. online courses; automatic assessment; computer algebra; examinations; verifiable credentials; digital certificates; personal record chain; Bitcoin anchoring; messenger applications; protection of minors.

Suggested citation. Nechesov, A. (2026). *Enigma Academy: Courses, Examinations and Verifiable Certificates inside a Messenger*. IAIC Technical Reports, IAIC-TR-2026-04. IAIC AI Research & Trading FZCO, Dubai, UAE.
https://doi.org/10.66693/iaic.tr.2026.4

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1. Introduction

Employers and universities need to know what a person can do. A language model now explains any topic on request, so an explanation is easy to obtain. A trustworthy check is harder to obtain: a check that a solution is right, that the person who presents a result is the one who earned it, and that the record was not changed afterwards.

Enigma Academy puts courses where people already talk, in the Enigma messenger, and builds the check into every step. A course arrives as messages with buttons in a chat whose goal is the course; problems are checked as they are solved; examinations produce results signed by the examiner responsible for them; and each result enters the learner's own record chain, whose fingerprint reaches the Enigma Root daily and Bitcoin through the Root's anchor.

The ledger is IAIC-TR-2026-01 [1]; the commitment protocol is IAIC-TR-2026-02 [2]; the platform for organisations, with sign-in through ENIGMA accounts and the daily anchor, is IAIC-TR-2026-03 [3]. This report adds the application interface of the messenger and the first application built on it, the learning layer, and cites the other reports for the rest. Section 12 states which parts run today.

2. Terms

Term	Meaning
Application	A service with its own server that works with people in chats through the application interface. A course is one.
Application interface	The calls, events and client surfaces the messenger gives to every application.
Learner	A person taking a course, with an ENIGMA account.
Parent	The adult linked to a learner under 18, who consents and sees progress.
Author	The person who writes a course and its problem templates.
Examiner	The person responsible for an examination; signs results with an examiner key. Often the author.
Course editor	The person who approves a course before it is published.
Problem template	A parametrised problem whose answer is computed for every variant; no answer is stored.
Attempt	One sitting of a topic test or an examination, with its score, whether passed or not.
Record chain	The learner's own sequence of signed records, each naming the previous one.
Certificate	A record of a passed examination, held by the learner.
Presentation	A certificate shown to someone, signed at that moment by the learner's key.
Key directory	The public list binding examiner keys to examiners.

3. Design Principles

P1. The machine checks where it can decide; a named person where it cannot. Every verdict says which one decided.

P2. AI is used for explanation only. Language models explain topics and give hints, and no certificate depends on a model's judgement alone.

P3. Fresh problems for everyone. Tests and examinations are drawn from templates for each learner and each attempt.

P4. No names on any chain. Chains carry fingerprints only; names, scores and videos stay off chain.

P5. The learner holds the result. A certificate is shown by its holder and signed by the holder's key when shown.

P6. Children first. Learners under 18 are linked to a parent; children under 13 learn without messaging.

P7. One account, the existing plans. Learning uses the ENIGMA account and the plans already sold; limits differ by plan. Free courses are open to every account without a plan.

P8. One interface for every application. Courses use the general application interface of the messenger; nothing in it is specific to learning, and other services use it unchanged.

P9. No asset; status stated plainly. No coin or token; each component is marked running or specified.

4. Architecture

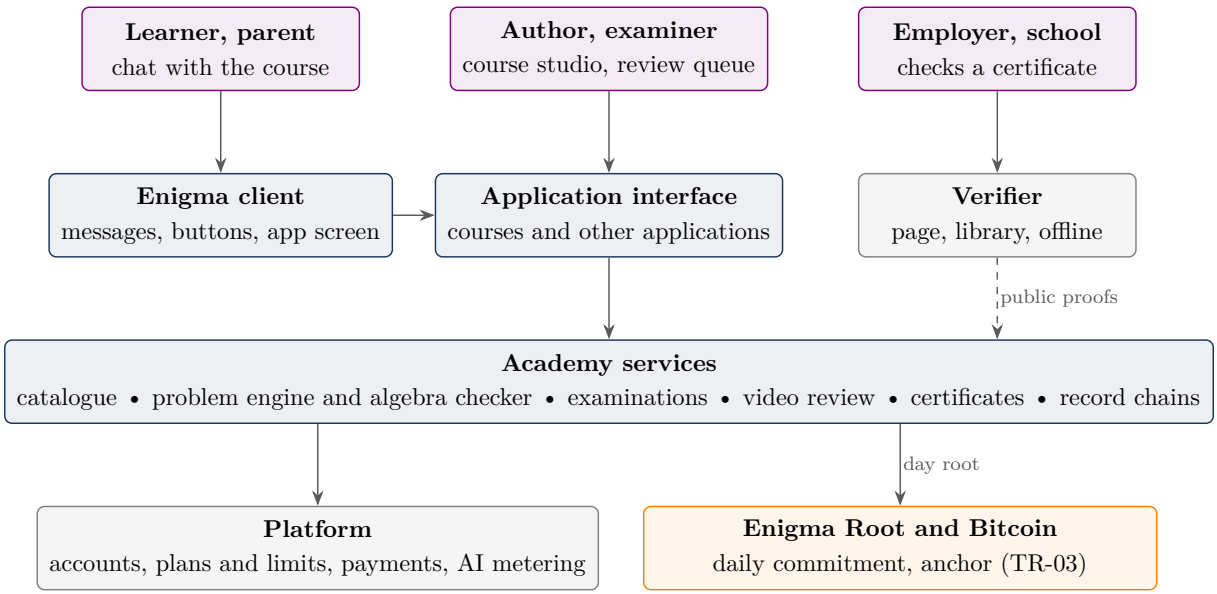


Figure 1: Components. A course is an application on the application interface, which other applications use as well; the services check, examine and record; the platform carries accounts, plans and payments; the Root and Bitcoin fix the records.

4.1 Roles

Role	May	Cannot
Learner	Take courses, solve, sit examinations, hold and present certificates	Present another learner's certificate (it needs the holder's key)
Parent	Create a child profile, consent, see progress and reports	Sit an examination in the child's name
Author	Write courses, templates and examination rubrics	Publish without the course editor's approval
Examiner	Review video answers; sign results with the examiner key; paid a fixed fee per review	Change a result after it is recorded; a correction is a new record
Course editor	Approve courses and their examinations	Issue certificates
Operator (IAIC FZCO)	Run the services and the Root's member for the Academy; sign with the keys it holds for learners, on their instruction	Forge an examiner's signature, or the signature of a key that a learner made

5. Application Interface

Courses have no interface of their own. They use the application interface of the messenger, which is general: any service that works with people in chats can be built on it, as bots and mini applications are built on a messenger [4]. Courses are the first application built on it. The Academy writes its courses on the interface that institutions and other developers will use, so a later application needs no change in the messenger.

5.1 What an application is

An application has a server of its own and three surfaces in the client.

- **A bot** is the application's account in a chat where a person or a group added it. It posts messages with buttons and receives the taps and the replies addressed to it. It reads nothing else in the chat.
- **An application screen** is a page served by the application and opened by the client over the chat, for work that does not fit a message: solving line by line, a form, a video, a recording.
- **A goal link** attaches the application to the goal of a chat. The application reads the goal and closes a step with proof, for example a passed topic test.

The platform does not run an application's code, and the client does not give an application the person's session.

5.2 Launch data

When a person opens an application, the client passes it a short statement signed by the platform. The application checks the signature against the platform's published keys, so the two share no secret.

```
{
  "app": "academy", "user": "u_7Q2M", "chat": "c_19F", "goal": "g_3KD",
  "age_band": "13-17", "locale": "en", "iat": 1795075200, "exp": 1795075500
}
```

The `user` value is a pseudonym made for this application: two applications cannot tell that they serve the same person, and a name or a contact reaches an application only when the person agrees. The age band stands in place of a date of birth.

5.3 Calls and events

An application calls the platform over HTTPS at `api.enigma.ist/apps/v1` with its own API key and receives events as signed webhooks.

Group	What an application can do	Permission
Messages	Post a message with buttons to a chat where it was added; receive the taps and the replies addressed to it	Post in this chat
Screen	Open its screen from a button; use the client's bridge: theme, back, main button, share to the chat, close	None
Goals	Read the goal it is attached to; close a step with proof	Read or update this goal
Plans and limits	Ask whether the person's plan covers a feature; learn that a plan started or ended	None
Records	Issue a record (a badge, a certificate, a receipt), append it to the person's record chain and commit its fingerprint	Issue records; reviewed applications only
AI	Ask for an explanation or an answer within the person's AI allowance	Use the person's allowance
Members	Read the names of a group's members who agreed to share them	See members of this group

A message with buttons, as a course posts it:

```
{
  "chat": "c_19F",
  "text": "Problem 3 of 5. Find the eigenvalues of [[2, 1], [1, 2]].",
  "buttons": [
    [ {"text": "Solve",   "action": "open_screen", "screen": "solve/p3"},
      {"text": "Hint",    "action": "callback",    "data": "hint:p3"} ],
    [ {"text": "1 and 3", "action": "callback",    "data": "answer:p3:a"},
      {"text": "2 and 2", "action": "callback",    "data": "answer:p3:b"},
      {"text": "0 and 4", "action": "callback",    "data": "answer:p3:c"} ]
  ]
}
```

5.4 Rules for every application

- **Permissions.** An application asks for its permissions when it is added; the person sees the list and can withdraw any of them. An application can do nothing it was not granted.
- **Pseudonyms.** Each application sees its own identifier of a person. It does not see the account, the phone number or the address.
- **Minors.** An application reaches a learner under 18 only in a family or class group where a parent or a teacher added it. Applications for minors are reviewed before listing and carry no advertising and no tracking code.
- **No currency.** There are no coins, stars, credits or balances inside applications. In this version an application sells nothing: it reads what the person's plan covers.
- **Review and suspension.** An application that issues records or serves minors is reviewed before it is listed. The operator can suspend an application; records it has issued stay verifiable.
- **Limits.** Calls are limited per application and per chat.

5.5 Courses and other applications

The interface was designed for more than one use. The table gives the first application and examples of others that need nothing beyond the groups above.

Application	Groups it uses	Example
Course (this report)	Messages, screen, goals, plans, records, AI	A lesson, a problem checked line by line, a certificate
Conference	Messages, screen, goals, records	The programme, the submission of a talk, a ticket shown as a code, a certificate of participation
Records of an organisation	Screen, records	The fingerprint of a document committed through the ENB Platform [3] and its receipt returned to the chat
Votes and surveys	Messages, records	A ballot with buttons in a group; the fingerprint of the result committed
Service requests	Messages, screen, goals	A request opened as a goal and closed with proof that it was done

The rest of this report specifies the first application, the Academy. Applications by other developers are admitted in steps: the operator's own first, then partners under contract, then a public developer portal.

6. Courses and Problems

6.1 Structure

A course has topics; a topic has lessons, practice and a topic test; the course ends with an examination. School mathematics is written to the depth of the Russian general-education programme (mathematics in grades five and six, algebra and geometry from grade seven, the beginnings of analysis in grades ten and eleven) and mapped, chapter by chapter, to the national curricula of the countries served, the NCERT textbooks of India first, so that a learner can follow the order of their own school. University courses follow a syllabus published with the course.

6.2 Free courses and full courses

Every problem template carries one of four levels of difficulty: basic, medium, hard and ultra. A course is offered in two layers that share its topics and lessons.

- **A free course** is open to every account in every country, without a plan. It covers all topics of the subject at the basic and medium levels, with lessons, explanations prepared in advance, practice checked automatically, topic tests and topic badges. It is complete in itself and brings a learner to a working understanding of the subject at the level of general education. A learner who cannot pay stops here and keeps everything learned and every badge earned.
- **A full course** is included in the paid plans. It adds the hard and ultra levels, preparation for the examination, the examinations of Section 7 and the certificates of Section 8.

The free layer costs the operator little: checking is done by the algebra system and explanations are prepared once for all learners, while hints from a language model stay within the allowance

of a free account.

6.3 Problem templates

A template states the problem with parameters, the constraints on them and the computation of the answer. The engine draws parameters for each learner and each attempt and computes the answer with a computer algebra system, SymPy [5]; nobody stores answers, and no two learners need see the same numbers.

```
{
  "id": "alg.linear.eq.01",
  "level": "basic",
  "statement": "Solve {a}x + {b} = {c}.",
  "params": {"a": "int(2..9)", "x": "int(-9..9)", "b": "int(-20..20)"},
  "derive": {"c": "a*x + b"},
  "answer": "x",
  "check": "equivalent"
}
```

6.4 Checking modes

Mode	How a step is decided
Exact answer	A number, a choice or a set, compared with the computed answer
Equivalent expression	The algebra system decides whether the learner's expression equals the computed one
Line by line	Each line of a derivation must follow from the line before; the first line that does not is shown
Structured proof	Statements and reasons chosen from a list, each checked against the rules of the topic
Program	Code run against tests in an isolated sandbox
Written explanation	Marked "AI judgement" and never decisive for a certificate; reviewed by an examiner where it counts

6.5 Explanations and hints

A language model explains a topic in other words, gives a hint without the answer, and explains the first wrong line. Its use is metered against the learner's plan, as every AI feature of the platform is. Typed derivations are checked by the algebra system without a model, which keeps the cost of checking near zero.

7. Examinations

7.1 Automatic examinations

An examination is drawn from the course's templates for each attempt, with a time limit and a pass mark set by the author and approved by the course editor. The examiner of the course signs the examination's definition with the examiner key; every result issued under it names that examiner.

7.2 Attempts

Every attempt is recorded, passed or not, with its score, date, examination and examiner, as a record in the learner's chain. The record's fingerprint is committed like any other; the record itself is shown only by the learner, or by the parent of a minor. Attempts are limited per period so that an examination cannot be ground through by repetition.

7.3 Video answers

For an expert certificate the learner records, inside the application, a video of five to ten minutes answering problems drawn for that attempt. The examiner reviews it against a published rubric and records a decision signed with the examiner key. The video is stored off chain, only its fingerprint enters the record, and it is deleted after a retention period (ninety days by default), the decision remaining.

8. Certificates and Records

8.1 Three levels

Level	Earned by	Confirmed by
Topic badge	A topic test	The service
Course certificate	All topics and the automatic examination	The service, under the examination signed by the course's examiner, who is named
Expert certificate	The above and a video answer	The examiner personally, by signature

A certificate states that a course was completed with checked work. It is not a school or university qualification and is not issued by any board, and it says so.

8.2 The personal record chain

Each learner has a key bound to the learner's ENIGMA account (IAIC-TR-2026-03 [3]). In the first version the platform holds this key, so that every account has one at once and signing needs no step by the learner; a learner may bind a key of their own, made on their own device. Every record states which kind of key signed it. Every record of the learner (enrolment, topic, attempt, certificate, correction) is an entry that names the previous one, so no entry can be removed or

reordered unnoticed.

```
struct RecordEntry {        // kept off chain, in the learner's record chain
    bytes32 prev;           // id of the learner's previous entry
    uint32  seq;            // position in the chain
    uint8   kind;           // enrolment, topic, attempt, certificate, correction
    bytes32 payloadHash;    // SHA-256(salt || JCS(payload)); the payload never on chain
    bytes32 issuerKeyId;    // the examiner's key, or the Academy service's key
    uint64  issuedAt;
}
// entryId = SHA-256(0x00 || JCS(entry)); signed by the issuer, countersigned with the learner
    's key
```

The payload (name, course, score, examiner) is encoded canonically [6] and salted, so its fingerprint reveals nothing. Each day the Academy builds an RFC 6962 Merkle tree [7] over the ids of all entries made that day and writes its root to the Enigma Root as a member commitment of IAIC-TR-2026-02 [2]; the Root anchors its day in Bitcoin through OpenTimestamps [10, 11], as IAIC-TR-2026-03 [3] specifies. No chain carries a name of a learner or an examiner, a score, or a video.

8.3 Names only when shown

The certificate, with the names, the score and the examiner's signature, is held by the learner. Showing it, the learner signs a presentation: the certificate, the audience and a fresh nonce, signed with the learner's key. With a key held by the platform the signature is made by the platform on the learner's instruction; with a key of the learner's own it is made on the learner's device. The verifier then sees the certificate in full, by the learner's choice. Two things are public: the key directory, which binds examiner keys to examiners, and a list of revoked entries, which holds fingerprints only.

RootFromPath is the audit-path computation of RFC 9162 [8]; signatures are typed-data signatures [9] as on ENB.

8.4 Exchange with other systems

A certificate can be exported as a W3C Verifiable Credential [12] in the form of the Open Badges 3.0 standard [13], signed by the examiner's key, so that wallets and learning records of other providers can hold it. The fingerprint and the anchor remain the reference.

9. Minors and Data Policy

School courses mean learners under 18, and in the lower grades under 13. The rules point the same way in the markets first served: India's data-protection law treats everyone under 18 as a child and requires verifiable consent of a parent [14]; United States rules require verifiable parental consent under 13 [15]; and Google Play requires adult controls over social features in applications whose audience includes children [16]. The Academy therefore applies these rules:

Algorithm 1 Verify a presented certificate

Require: certificate payload c with salt s; entry E with issuer signature σ_I and learner signature σ_L; presentation signature π over $(\mathrm{id}(E), \mathit{audience}, \mathit{nonce})$; audit path p; day commitment D; anchor proof P

if $E.\mathit{payloadHash} \neq \mathrm{SHA256}(s \,\|\, \mathrm{JCS}(c))$ **then**
  return INVALID
end if
if σ_I does not verify, or the issuer key was not in the key directory at $E.\mathit{issuedAt}$, or $\mathrm{id}(E)$ is revoked **then**
  return INVALID
end if
if σ_L or π does not verify with the learner key named in c, or the nonce is not the verifier's **then**
  return INVALID
end if
if ROOTFROMPATH$(\mathrm{id}(E), p) \neq D.\mathit{recordsRoot}$ **then**
  return INVALID
end if
if P attests the Root's day containing D in a Bitcoin block **then**
  return VALID
end if
return PENDING

- every learner under 18 is linked to a parent who consents;
- a child under 13 learns in a profile created by the parent, with no messaging, no people search and no public profile;
- videos of minors are recorded only with the parent's consent, seen only by the examiner, and deleted after review;
- on a public verification page a minor's name appears only if the parent chooses;
- courses for children under 13 are advertised only after legal review in each market.

Data	Where it is kept	Never
Names, scores, answers	Academy services, the learner's record chain	On any chain
Videos	Academy storage, for the retention period	On any chain; after the retention period
Fingerprints of records	The day's Merkle tree; its root on the Enigma Root	Without salt for personal records
Examiner keys	The public key directory	Private keys on the platform

10. Plans and Limits

Learning uses the ENIGMA plans already sold, so that a person does not choose between an AI plan and a learning plan. Nothing is sold separately: a plan sets limits, and everything a learner

can do is inside a plan.

- **AI allowance:** explanations and hints count against the plan's allowance, as every AI feature of the platform does.
- **Free courses:** open to everyone without a plan, in every country and in full (Section 6.2).
- **Full courses:** included in the paid plans: the higher levels of difficulty, the examinations and the certificates.
- **Automatic examinations and course certificates:** included in every paid plan, with a limit on attempts per period.
- **Examinations reviewed by an examiner:** open only to the two higher plans, with a monthly number of reviews included in each (one on the middle plan and three on the highest at launch). Unused reviews do not carry over, and none are sold beyond the plan.
- **Family seats:** a parent's plan covers linked children, who share its limits.

A learner is admitted to a reviewed examination only after passing the course's automatic examination, so an examiner's time goes to prepared candidates.

Examiners are engaged by the operator under contract and paid a fixed fee for each completed review, set by the level of the course. Their pay does not depend on whether the learner passes, which keeps the decision free of interest. Authors are paid a fixed fee for an accepted course. Learners pay the operator only, through Google Play in the Android application and the platform's payment provider on the web; no payment is made in a token.

11. Security and Integrity

Threat	Control	Residual risk
Answers passed between learners	Fresh variants for every attempt; attempts limited	Help during an attempt
A model solves for the learner	Line-by-line checking of the learner's work; a video answer for expert certificates	Automatic certificates prove that the work was completed and do not prove who did it
Forged certificate	Examiner signature, key directory, fingerprint, anchor	None after anchoring
Someone else's certificate shown	Presentation signed with the holder's key and the verifier's nonce	Takeover of the learner's account; for a key of the learner's own, theft of that key
Examiner key compromised	Hardware or device-held keys; revocation list; key validity periods	Results signed before revocation stay valid unless revoked individually
Operator misconduct	Cannot sign for examiners, nor with keys that learners made; keys it holds for learners are marked as such; history anchored	A record signed with a key the platform holds rests on trust in the operator until its day is anchored
Leak of personal data	No names, scores or videos on chains; salts off chain	Leak from the services' own storage
A careless or hostile application	Permissions granted when it is added; a pseudonym per application; no reading of messages not addressed to it; review before listing; suspension	Data a person chooses to give the application

12. Implementation Status and Plan

12.1 State in November 2026

Component	Status
Enigma messenger on Android, Windows, Mac and the web, with groups, channels, chat goals and AI within plan limits	RUNNING
ENIGMA accounts, the plans and their payments through Google Play and the web	RUNNING
Course enrolment, certificate serial numbers and a public verification page, from the first paid course	RUNNING
ENB test network and a daily commitment of the platform's records	RUNNING
Application interface	SPECIFIED
Problem engine and algebra checker, examinations, video review	SPECIFIED
Personal record chains, presentations, key directory, revocation list, export as Open Badges	SPECIFIED
Child profiles and parent links	SPECIFIED

12.2 Plan

When	Work	Complete when
December 2026	Application interface, the parts that courses use; problem engine; automatic courses of school mathematics, grades five to nine; topic badges; child profiles	Courses open; first badges verifiable
January 2027	Video courses by invited authors, approved before publication; course studio; examiner review queue	Two video courses published
February 2027	Examinations and certificates on all levels; record chains and presentations; examiner reviews within the two higher plans	First certificates presented and verified
March–June 2027	Further sciences; university courses; export as Open Badges; employer verification page	Courses in several subjects
Second half of 2027	Lower grades after legal review; institutions as authors with their own examiners; a first application other than courses on the same interface	Partner institutions issuing; a second application running

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A. Document History

Report	Date	Notes
IAIC-TR-2026-01	2026-11-14	Enigma Blockchain (ENB): the tokenless ledger.
IAIC-TR-2026-02	2026-11-18	Enigma Root of Trust: the commitment protocol.
IAIC-TR-2026-03	2026-11-23	ENB Platform: organisations, ledger checkpoints, the daily anchor.
IAIC-TR-2026-04	2026-11-23	Enigma Academy: courses, examinations and certificates inside the messenger.
	2026-11-23	Revised on the day of publication: the learner's key is bound to the ENIGMA account and is held by the platform in the first version; wording made plainer in several places.

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