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LOW-COST, HIGH-CONSISTENCY PROCESS FLOW FOR AUDIO-VISUAL E-LEARNING CONTENT DEVELOPMENT FOR FOUNDATIONAL COMPUTER EDUCATION ON YOUTUBE

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Abstract: Educators increasingly need a repeatable, budget-conscious workflow to produce YouTube-ready, audio-visual lessons without sacrificing technical quality or instructional clarity. This paper formalizes a low-cost, high-consistency process flow tailored to foundational computer education and the realities of a solo creator. This study details an end-to-end pipeline optimized for a screen-recording-first setup with affordable peripherals. The contribution is practical and reproducible: a role-agnostic flow with explicit inputs/outputs and quality gates; hardware/software stack mappings; export and archival presets; a YouTube-specific metadata checklist; and a risk register addressing common constraints. To support adoption at different budget levels, this study provides cost tiers with trade-offs and upgrade paths. A brief case snapshot demonstrates feasibility in a real production context, and all operational checklists and presets are presented within the main text.

Keywords: *E-learning, Computer Education, Content Creation, YouTube, Low-cost Workflow, Solo Content Creation*

1. INTRODUCTION

Creating course-ready video lessons for open platforms like YouTube has become a pragmatic choice for higher education because distribution is free, the audience is broad, and the format supports visual and procedural explanations that suit computing subjects. Recent syntheses underline both the opportunity and the fragmentation of practices: a 2022 IEEE Access scoping review (647 studies) shows that research spans four themes—content creation and assessment; user attitudes and acceptance; usage strategies and behaviors; and learning impact—but best-practice production workflows for creators remain unevenly described [1].

For educators operating as solo or small-team creators, practical barriers—equipment choices, audio quality, screen-capture technique, motion graphics, editing time, export standards, and metadata—often matter more than pedagogy per se. Audience research on educational channels highlights that viewers quickly disengage when delivery is flat or when audio–video quality is weak—evidence that technical consistency is a prerequisite for instructional value on video platforms [2].

Alongside pedagogical literature, a parallel body of work examines the creator economy and cost constraints that shape sustainable production: qualitative studies of "edu-creators" describe how independent educational channels adapt platform monetization and workflow decisions to remain viable, pointing to the need for low-cost, reproducible pipelines that preserve quality [3].

At the level of technique, systematic reviews and design studies document concrete audiovisual production and workflow scaffolding elements (e.g., staged processes, role/task definitions, assets reuse) that measurably improve novice creators' video-production capabilities—exactly the kind of prescriptive guidance needed for foundational computing tutorials [4, 5].

Complementary work on EduTubers also argues for making production choices explicit (planning, editing, on-screen text/graphics, analytics-informed iteration) to support creator professionalism [6].

The pipeline discussed in this paper targets first-year undergraduate students studying courses related to foundational computer education. It presents a practical, low-cost, and repeatable process flow for producing consistent audio-visual lessons for foundational computer education on YouTube for the target group. The aim is to help individual instructors and small teams achieve steady quality with limited budgets and basic equipment. The process covers planning, scripting, recording, editing, quality control, and publishing, with clear checkpoints that reduce variability from one video to the next. Researchers of this paper have documented cost-saving choices, simple templates, and lightweight tools that minimize rework while keeping the learner experience coherent.

They have also reported time and expense profiles from an extended production run to show how the process scales for solo creators. Finally, this paper discusses trade-offs and practical constraints so others can adapt the flow to their own contexts. Important to mention- this study focuses on production logistics for solo creators and does not evaluate test-score gains or cognitive impact. The pipeline is tool-agnostic by design where feasible: any functionally equivalent tool may be substituted without changing the sequence of steps. Team role definitions and role-specific SOPs are out of scope for this paper.

Section 2 of this paper describes the production context and constraints; Section 3 lists the hardware/software stack and cost tiers; Section 4 presents the end-to-end process flow; Sections 5–8 detail pre-production, production (capture), post-production, and publishing; Section 9 covers risk management; Section 10 discusses scalability; Sections 11–12 provide limitations and conclusions.

2. Production Context and Constraints

The pipeline is operated by a solo creator, with all roles (scripting, capture, editing, audio treatment, graphics, upload) performed by one person. Average video duration is ~17.6 minutes (21 videos totaling 369.6 minutes). The sequence regularly follows 13 steps from topic selection through upload.

Two recurring constraints shape production logistics: environmental noise and power cuts. Noise is managed by disabling nearby appliances (fan, AC, fridge) during recording; no additional acoustic treatment is used. Power continuity relies on a UPS.

Screen-recording-first workflow with no capture card or dedicated camera (occasional Samsung S23 Ultra [12]). Input is via Wacom One CTL-472 [8] + OpenBoard [13] as a virtual writing board. Workstation specs: Intel i7-7700K, 16 GB RAM, GTX 1060 6 GB, 256 GB SSD + 2 TB HDD; backups via Google Drive/OneDrive; UPS in use.

Audio Recording uses BOYA BY-PM700 USB condenser mic (no external interface) [7], with consumer headphones for monitoring; capture via Camtasia Studio [10]. Adobe Premiere [11] is used for video editing; Audacity [14] for noise reduction/EQ/leveling; After Effects for logo/outro graphics.

No subtitles currently included in the production plan. Thumbnails are prepared in Adobe Photoshop at 1280×720 (16:9), JPG < 2 MB, with per-series visual identity. Regarding Metadata policy- concise, non-clickbait titles are used; script-derived keywords are formed; chapters identified with timestamps in the description; end-screen deployed as a triad (best for viewer / most recent / subscribe); no cards included. Background music (when used) is copyright-free from YouTube Audio Library [15].

Primary broadband ~90 Mbps with mobile hotspot as backup (not used for heavy uploads); mobile data cap 5 GB. Table I outlines the primary constraints in the current setup and their mitigations strategy.

TABLE I. CONTEXT & CONSTRAINTS (WITH MITIGATIONS)

Domain	Current Setup	Primary constraint (s)	Mitigation / policy
Team & cadence	Solo creator; ~18-minute videos; 13-step sequence	Throughput vs. single-operator load	Standardized steps and artifacts to reduce context switching
Environment	Home/office room; appliances off during recording	Ambient noise	Switch off fan/AC/fridge; record during quieter hours
Power	UPS available	Power cuts mid-session	Record in UPS window; frequent saves; short takes
Capture & audio	Camtasia screen record; BOYA BY-PM700 USB mic; HP headphones	Room acoustics; no audio interface	Mic technique & distance; post NR/EQ in Audacity
Writing surface	Wacom CTL-472 + OpenBoard	Handwriting legibility at small scales	Use thicker pen presets; 1080p canvas; cursor highlight
Workstat	i7-7700K /	Disk	Periodic

ion & storage	16 GB / GTX 1060; 256 GB SSD + 2 TB HDD	headroom during long sessions	media offload; archive after export
Backup	Google Drive & OneDrive	Version sprawl	Folder conventions; dated export folders
Publishing	No subtitles; Photoshop thumbnails 1280×720 JPG <2 MB; no cards	Discoverability; accessibility	Clear titles/chapters; plan future captioning
Music & rights	YouTube Audio Library	Policy changes/claims	Maintain asset log; keep license notes
Network	~90 Mbps broadband; hotspot backup (5 GB cap)	Upload failures during outage	Avoid heavy uploads on hotspot; schedule off-peak

3. Hardware and Software Stack

This stack is optimized for a screen-recording-first pipeline run by a solo creator, prioritizing clear handwriting capture, clean voice-over, simple graphics, and reliable exports—without a capture card or studio lights. Core inputs are a Wacom One CTL-472 writing tablet feeding OpenBoard, voice via BOYA BY-PM700 USB mic (no audio interface), screen capture in Camtasia, editing in Premiere Pro, audio cleanup in Audacity, motion elements in After Effects, and thumbnails in Photoshop (1280×720 JPG <2 MB). Connectivity is ~90 Mbps broadband with a mobile hotspot backup; power continuity via UPS [9].

TABLE II. STACK INVENTORY AND ROLE

Category	**Primary tool/ mode**	**Role in pipeline**	**Key notes**
Voice capture	BOYA BY-PM700 (USB condenser)	Clean narration / VO	No dedicated interface; monitored with consumer HP headphones.
Writing input	Wacom One CTL-472 + OpenBoard	On-screen handwriting / diagrams	Virtual whiteboard workflow; no document camera or physical board.
Screen capture	Camtasia Studio	Record screen + system audio/cursor	Screen-recording-first setup; no capture card.
NLE (editing)	Adobe Premiere Pro	Timeline edits, overlays, export	Final conforms before upload.
Audio post	Audacity	Noise reduction, EQ/level, re-sync	Post-processing done entirely in Audacity
Motion graphics	Adobe After Effects	Logo animation, outro	Reusable brand elements.
Thumbnails	Adobe Photoshop	1280×720 JPG <2 MB thumbnails	Series-consistent branding.
Workstation	i7-7700K / 16 GB / GTX 1060 6 GB / 256 GB SSD + 2 TB HDD	Editing, renders, storage	Backups to Google Drive & OneDrive; UPS in use.
Power & network	UPS (Power	Continuity and	Hotspot for light

	Guard); Broadband ~90 Mbps + hotspot backup	uploads	fallback (5 GB cap).

All entries in Table II reflect the documented creator pipeline.

The incremental tiers demonstrated in Table III shows what it costs to assemble/upgrade a solo-creator kit around the existing workflow. Prices fluctuate across Bangladeshi retailers; ranges below use current public listings and official vendor pages (price point may vary in future time).

TABLE III. COST TIERS

Component	**Entry (budget)**	**Mid (balanced)**	**Pro (upgrade path)**
USB mic	BOYA BY-PM700: BDT6,200	Add pop filter/boom arm (small add-on)	Move to XLR mic + interface (not priced here)
Pen tablet	Wacom CTL-472: BDT6,250 – BDT7,500	Larger drawing area if desired	Full pen display (optional, not required for this pipeline).
Power	650 VA UPS (Power Guard) ≈ BDT 3,700	850–1200 VA class	Line-interactive /online UPS; multi-outlet PDU.
Screen capture	Camtasia $179.88/yr (Essentials)	Teams/Business plans as needed	Alternative capture on dedicated PC (optional).
Editing / graphics	Adobe Creative Cloud (All Apps): $54.99–$69.99/mo (Standard vs. Pro)	Add stock assets as needed	Team plan; cloud collaboration

In Table III, the Entry column gets production-ready audio, handwriting capture, power continuity, and the required software. Mid adds ergonomic and resilience upgrades. Pro targets longer sessions and collaborative scaling.

Tooling note: Researchers used Audacity for audio treatment. Other tools can be substituted provided they meet the same functional requirements (e.g., noise reduction, EQ, compression, and export settings aligned to the process checkpoints). This research work did not benchmark proprietary versus open-source options; institutions may choose alternatives according to policy, licensing, or resource constraints without changing the pipeline's steps.

4. End-to-End Process Flow

Building on the context (Section 2) and the concrete stack (Section 3), our process is a single-operator, screen-recording–first pipeline designed to keep quality predictable and costs contained. Each video passes through five linked phases—pre-production, capture, post-production, publishing, and quality assurance/archival—so that inputs and outputs are uniform and hand-offs are frictionless. In practice, a topic is locked to a tight scope; the script is drafted in Google Docs with timing notes and on-screen cues; OpenBoard scenes are prepared for handwriting on the Wacom tablet; and a short "quiet-room" routine (fan/AC/fridge off, UPS OK) precedes recording. Capture happens in Camtasia on a fixed canvas with consistent cursor highlighting and mic placement (BOYA BY-PM700 USB). Post-production opens in Premiere for the rough cut and conform; voice is round-tripped to Audacity for noise reduction, EQ, and level normalization; brand intro/outro are inserted; then a standard 1080p export preset produces the master. Publishing is handled in YouTube Studio using a repeatable metadata pattern (title, description with chapters, end-screen triad) and a Photoshop thumbnail template. Finally, a full watch-through confirms technical integrity, and the project folder, master file, and thumbnail are archived to cloud storage with a brief log entry.

Progression between phases is governed by lightweight gates to prevent rework. Before leaving pre-production, the script is self-approved and the OpenBoard scene plan is ready. A 10-second test clip verifies noise and levels before committing to full capture. Post-capture, the timeline must match the script beats before audio is exported for treatment; the

cleaned WAV returns with peaks and average level within target. Picture lock precedes brand insertions; the export step uses the same preset each time; publishing completes only once YouTube has produced the 1080p rendition and a quick watch reveals no dropped audio, harsh cuts, or illegible on-screen writing. If any critical fault is discovered late (e.g., noise burst, clipping, or cursor visibility issue at a chapter boundary), the flow deliberately permits a short return to capture for a pickup and a fast re-conform, minimizing wasted effort. On rare occasions an on-camera intro from a smartphone may be added ahead of the main screen segment, but this branch does not alter the core path.

5. Pre-Production

Pre-production remains deliberately light but uncompromising about repeatability. The aim is to begin recording with every creative decision settled—what is said, what appears on screen, where chapters will break, and how assets are organized—so capture is an execution step rather than exploration. A topic is scoped to a single, demonstrable unit in foundational computing. The script is drafted in Google Docs with tight cueing: narration in plain text, brief on-screen actions in brackets, and provisional mm:ss markers at natural pauses that convert to chapters later. Short, active sentences reduce retakes and keep pacing crisp; key technical terms that must be visible on screen are flagged in the script for legible rendering.

Visual preparation follows one of two paths, depending on the nature of the material. When step-by-step derivations, hand annotations, or algorithmic traces are central, OpenBoard scenes are staged for handwriting on the Wacom tablet. Scenes align one-to-one with script beats and are arranged so writing grows left-to-right with generous margins; pen presets use a primary ink for body text, a high-contrast accent for emphasis, and a third color for warnings or counterexamples, all sized for comfortable reading at 1080p. For conceptual overviews, structured definitions, or figure-led explanations, the pipeline uses PowerPoint slides with voiceover. A minimalist 16:9 deck (1920×1080) is prepared with large, high-contrast typography, restrained builds (only when they aid pacing), and slide notes that mirror the narration cues. This dual approach—slides for high information density and OpenBoard for live reasoning—has been used extensively in practice; a substantial portion of produced content follows the PowerPoint-with-voiceover route, while OpenBoard is employed whenever live sketching improves clarity.

Asset planning and file hygiene begin before any recording. A predictable project structure is prepared and a proper naming convention is followed to ensure smooth production, version clarity, and painless archiving—details intentionally omitted here to keep the paper focused on process rather than local folder semantics. Prior to capture, a short quiet-room preflight is executed: nearby appliances are switched off, the UPS status is checked, notifications are silenced, the mic is positioned consistently (roughly 10–15 cm at a 30–45° angle), Camtasia's capture region is confirmed, and a 10-second test clip is recorded. Only after the test plays back clean—no hums, pops, or clipping—does full recording proceed.

Chapters and metadata are seeded at this stage to lower downstream load. A working title is drafted from the script's lead sentence; 4–6 keywords are pulled from the script's terminology; provisional chapter times are listed from the mm:ss cues; and the short thumbnail line is chosen now so the PSD can be updated immediately after export. These placeholders flow into YouTube Studio during publishing and are adjusted only if final timings shift.

The pre-production exit condition is explicit: script v1 locked with cues and mm:ss markers; either a slide deck (PowerPoint) or OpenBoard scenes readied to match the script beats; project organization established with a proper naming convention; and a clean preflight test clip recorded. With these items in place, capture becomes deterministic and consistency across videos is maintained.

6. Production

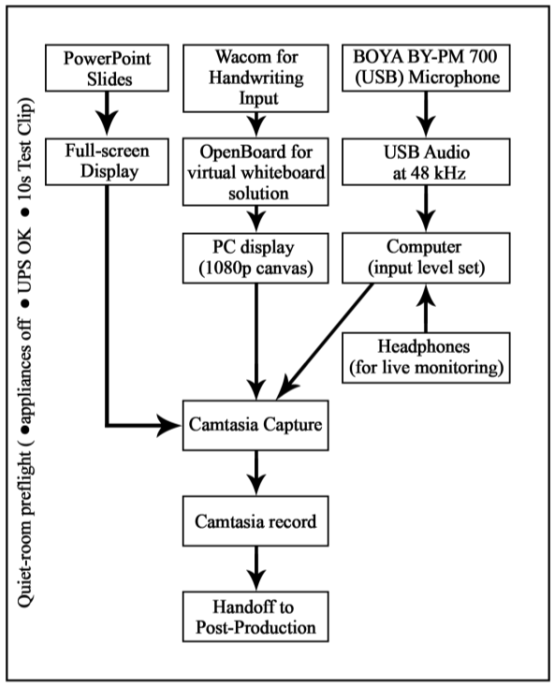

Fig. 1. Schematic Diagram

As demonstrated in Fig. 1., each session starts with the same brief quiet-room preflight (appliances off, UPS confirmed, notifications silenced, 10-second test), after which recording proceeds along one of two visual tracks—PowerPoint with voiceover for structured, figure-led explanations, or OpenBoard handwriting for live reasoning. Both tracks feed the same Camtasia chassis to keep the look and pacing consistent across videos.

Camtasia records a fixed 1080p region at a stable frame rate (30 fps) with the cursor highlight enabled; system audio is included only when demonstrations require it. Voice is captured via the BOYA BY-PM700 (USB) in cardioid mode with consistent placement and input gain set to avoid clipping. A simple headphone monitor closes the loop: if noise or level issues appear, the retake path is intentionally short—stop at the fault, mark the script line, and re-record only the affected segment—so the single-stream recording stays easy to splice without external sync.

When an on-camera introduction is useful, a brief 1080p/30 fps smartphone clip can be recorded in the same quiet setup and prefixed to the screen segment without altering the core capture chain. After recording, Camtasia produces a single .avi file (screen + mic). A fast confidence review at 2× checks cursor visibility, slide/handwriting legibility, and absence of clipping or dropouts. If clean, the take is handed off to Section 7 (Post-Production) for rough-cut conform, audio cleanup, and finishing; if not, only the minimal portion is re-captured and replaced.

7. Post-Production

Post-production turns a single-screen recording into a polished, platform-ready lesson without adding studio complexity. As demonstrated in Figure 2, the workflow begins by ingesting the captured .avi file (screen + mic) into a 1080p/30 Premiere project. A quick organizational pass places the recording on a single A/V track and aligns the timeline to the script beats from Section 5; this guarantees structural consistency before any polishing. A tight rough cut removes dead air, resets, and cursor hesitations; chapter boundaries are aligned to the provisional mm:ss cues so that later chaptering in YouTube Studio is mostly a copy-over step.

With structure locked, dialogue is exported as a WAV stem for an Audacity round-trip. The audio cleanup is deliberately conservative and reproducible: a short profile is used for noise reduction to tame the room's low-level hum; EQ applies a gentle high-pass to remove rumble and a modest presence lift for intelligibility; and overall level is normalized to a speech-oriented target so that the track sits near −16 to −14 LUFS (integrated) with true peaks ≤ −1 dBFS. The cleaned WAV replaces the original audio on the timeline to avoid stackable processing. Because the capture is single-stream and takes are short, re-sync is trivial and drift is not observed across typical ~18-minute lessons.

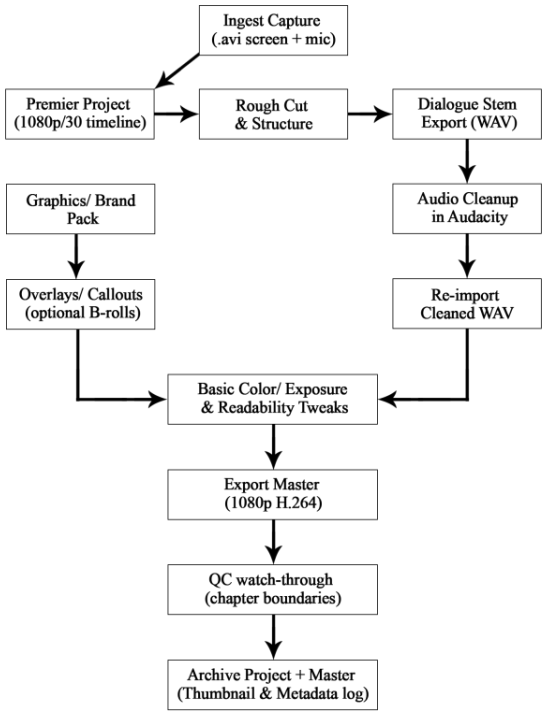

Fig. 2. Post-production Pipeline

Graphics and readability adjustments follow. A small brand pack (intro/outro, lower-thirds) is inserted where appropriate; any overlays or callouts are added sparingly to support, not distract from, the narration; and basic exposure/contrast tweaks ensure legibility of slides or handwriting on mobile devices. Cursor highlight and pointer visibility are spot-checked at chapter boundaries. A brief picture-lock review at 2× speed verifies that fixes have not introduced cuts over words, pops between edits, or unwanted jumps.

Export uses a single, repeatable 1080p preset that balances clarity with upload time and storage, and the master is named per proper naming convention. Before handoff to publishing, a QC watch-through at 1× confirms dialogue clarity, absence of clipping, and legibility of on-screen text/ink. If any defect is found, the pipeline allows a correction pass, preserving the throughput advantages of a screen-recording-first method. The approved master and project are then archived with the thumbnail and a brief metadata log to keep the catalog consistent.

TABLE IV. EXPORT PRESETS

Parameter	**Proposed Settings**	**Rationale**
Container	MP4	Widely compatible; efficient upload/playback.
Video codec	H.264 (AVC), High Profile	Quality at moderate bitrates; universal support.
Frame size / fps	1920×1080 @ 30 fps	Matches capture; avoids resample artifacts.
Rate control	CBR or high-quality VBR	Stable quality and predictable file size.
Target video bitrate	12–16 Mbps (1080p30)	Clear text/handwriting; manageable upload time.
Keyframe interval	2 seconds	Smooth seeking and stable compression.
Color space	Rec. 709, full levels preserved	Standard for web video; consistent look.
Audio codec	AAC, 48 kHz, mono or stereo	Transparent voice reproduction; platform-friendly.
Audio bitrate	192 kbps (mono) or 256 kbps (stereo)	Headroom for sibilants and music stingers.
Loudness target	≈ −16 to −14 LUFS (integrated)	Comfortable speech level; minimal platform gain changes.
True-peak ceiling	≤ −1.0 dBFS	Prevents inter-sample clipping post-transcode.

8. **Publishing**

Publishing turns the mastered 1080p export from Section 7 into a discoverable, consistent entry in the course playlist. The workflow is intentionally templated so that titles, descriptions, chapters, end screens, playlists, and thumbnails can be completed in a single pass and reviewed once before making the video public. Start by uploading the .avi-derived master (H.264 MP4) and waiting for YouTube to finish the 1080p rendition; only then finalize metadata and visibility. Titles follow the non-clickbait style established earlier—front-load the key concept, keep within ~65–70 characters for mobile truncation, and add series markers at the end (if needed). The first two description lines act as the "hook" that appears in search and shares; a crisp two-sentence summary is written, then paste the chapter list derived from the mm:ss cues locked in Section 5. After chapters, include a short "Key terms" line, links to the relevant playlist(s), and a one-line licensing/credits note (if needed).

Thumbnails are prepared from the PSD template at 1280×720 (16:9) JPG < 2 MB and checked for legibility at small sizes. Large, high-contrast text (3–6 words) is used with one focal graphic or icon, and the series' color system; stacking multiple elements is avoided that compete with the subject of the lesson. A quick grayscale preview helps confirm contrast for mobile users. End screens are configured with the standard triad—Best for viewer, Most recent, and Subscribe—timed to the last 15–20 seconds after the outro animation. Cards remain off in this pipeline. Finally, the video is placed into its course playlist, visibility is set, and the first minutes after publishing is skimmed to confirm chapters, thumbnail, and end-screen behavior render as expected.

TABLE V. YOUTUBE UPLOAD CHECKLIST (SINGLE-PASS)

Step	What to do	Source/ reminder	Status
Upload master	Upload the 1080p MP4 exported in Sec. 7	Confirm 1080p rendition before making	☐

	(derived from the .avi capture)	public	
Title	Non-clickbait; key concept first; ≤ ~70 chars; series tag at end if used	Script lead sentence	☐
Description (top)	1–2 sentences summarizing the lesson	Script abstract	☐
Chapters	Paste mm:ss list; verify boundaries after processing	Cues from script	☐
Key terms	4–6 keywords from script terminology	Metadata scratchpad	☐
Thumbnail	PSD → JPG **1280×720**, < 2 MB; high-contrast, 3–6 words	Template; quick grayscale check	☐
End screens	"Best for viewer" + "Most recent" + "Subscribe" (last 15–20 s)	Outro timing	☐
Playlist	Add to relevant course/series playlist(s)	Course structure	☐
License & credits	Set license; note any audio from YT Audio Library	Description footer	☐
Visibility	Schedule or publish; allow processing to complete	Wait for 1080p	☐
Post-publish skim	Watch first 2–3 minutes on mobile & desktop; verify chapters and thumbnail rendering	Spot-check pacing/legibility	☐

9. **Process Control and Risk Management**

This pipeline treats quality as a sequence of repeatable control gates that fire in the same places every time: before capture (quiet-room preflight), during capture (live headphone monitor with a short retake loop), before export (picture-lock plus audio targets), after export (QC watch-through), and after upload (1080p rendition check). Because a single operator owns all steps, each gate is designed to be fast and binary. A 10-second preflight recording must play back clean before any full take; cursor visibility and on-screen legibility must survive a 2× confidence review, especially at chapter boundaries; dialogue must land near −16 to −14 LUFS with true peaks ≤ −1 dBFS before export; and the video is only made public once YouTube finishes 1080p processing and a brief cross-device skim confirms chapters and end-screens render correctly.

The main risk domains are handled inside those gates rather than in ad-hoc fixes. Environmental noise is addressed by the quiet-room routine and cardioid mic placement; any residual hum is treated with conservative noise reduction in Audacity. Clipping is prevented by keeping input gain modest and validating loudness/true-peak targets prior to export. Room echo is reduced by close, slightly off-axis mic placement and a gentle presence EQ for intelligibility. Cursor loss or dense handwriting is avoided by a fixed 1080p canvas, an always-on cursor highlight, and thicker pen

presets checked at chapter marks. Power interruptions are absorbed by recording within the UPS window, working in short takes, and saving frequently. Storage and stability risks are kept in check with a pre-session headroom check, autosave/versioned saves, and cloud backups—so a corrupted timeline can be rebuilt from the captured .avi if necessary. Consistency at delivery is enforced by a single locked export preset; if YouTube stalls below 1080p, publishing is delayed. Copyright is contained by using the YouTube Audio Library and keeping a minimal asset log, and small metadata or thumbnail issues are caught by a one-pass upload checklist and a quick grayscale contrast check. To protect cadence, topics are scoped to a single concept, pre-production is batched where possible, and a small backlog is maintained to cushion week-to-week variability.

As a summary of the control plan- preflight passes before recording begins; the 2× confidence review passes before handoff to edit; loudness/true-peak and picture-lock pass before export; a full QC watch-through passes before archival; and 1080p availability plus a cross-device skim pass before visibility is set. If any check fails, the recovery path is intentionally minimal—a tight pickup, a micro-edit, or a re-upload—so quality stays high without compromising the low-cost, high-consistency promise of the workflow.

10. Reusability and Scaling

Scaling this pipeline does not depend on new gear; it depends on reusing decisions and batching work so one person can ship more lessons with the same quality. The core tactic is to freeze everything that can be standardized—canvas size, cursor highlight, mic placement, Audacity chain, export preset, thumbnail layout, and the one-pass upload checklist—so that creative energy is spent only on topic selection and explanation. Because capture yields a single .avi stream (screen + mic), the post path remains identical across lessons; this sameness is what allows volume without drift.

Batching raises throughput without raising error rate. Pre-production is grouped into short "script blocks" (e.g., three closely related concepts drafted back-to-back), followed by a single visual-prep block (PowerPoint slides or OpenBoard scenes prepared in one sitting), then a recording window where the quiet-room routine is run once and several lessons are captured sequentially. Post-production mirrors this cadence: rough cuts for the block are assembled in one session, dialogue stems are exported in one go and cleaned with the same Audacity settings, then returned to the timelines for finishing and a single export queue. Publishing is likewise batched: titles/ descriptions/ chapters are completed side-by-side to keep phrasing and terminology consistent across the series, and thumbnails are updated from the same PSD with only the text layer changed.

Asset re-use keeps costs flat and the brand familiar. The intro/outro, lower-thirds, callout styles, and slide master (or OpenBoard pen presets) are reused verbatim; only the lesson-specific text or diagram changes. A small "graphics pantry" (icons, arrows, highlight boxes) prevents ad-hoc design and speeds annotation when needed. Because the pipeline is screen-recording-first, even B-roll is optional; when it is added, short overlays are drawn from a tiny internal library rather than designed anew.

Lightweight documentation preserves quality as volume grows or if tasks are handed off. A one-page SOP per stage—preflight, capture, audio cleanup, export, upload—describes only the decisions that must never change and the pass/fail checks at each gate. If help is added, the safest early hand-offs are thumbnail updates and upload form-filling (title, description, chapters, end screens) because both are driven by the script and the locked checklist; the creator retains capture, audio cleanup, and final QC until confidence is established.

Finally, capacity planning keeps the pipeline healthy. A rolling backlog of two to three prepared scripts protects the schedule; off-peak uploads avoid contention with teaching duties; and storage is managed by archiving approved masters and project folders after the QC watch-through. The rule is simple: when something works once, turn it into a preset—and when a preset drifts, reset it to the known-good version—so that scaling up never erodes the "low-cost, high-consistency" character of the workflow.

11. Limitations

This paper is intentionally confined to the production side of YouTube lessons rather than their pedagogical effects. This study does not report controlled studies on learning gains, viewer cognition, or comparative analytics; the scope is a process blueprint grounded in a solo-creator context. As such, external validity to multi-role teams requires adaptation (e.g., formal hand-offs, shared asset libraries, role-specific checklists). Role-specific standard operating procedures (SOPs) for multi-role teams are not provided in this version; the workflow targets a solo-creator context. The pipeline is framed around screen-recording and affordable peripherals in a typical office/home environment without acoustic treatment; while the controls and gates are tool-agnostic in spirit, the concrete examples reference Camtasia → Premiere → Audacity, which are proprietary choices and may

not map one-to-one to every open-source stack. This research does not include a mapping or benchmarking of proprietary tools against open-source alternatives; only function-based substitutability is asserted. Platform emphasis is on YouTube; metadata and export decisions would need adjustment for other VOD/LMS platforms with different ingestion or caption policies. Accessibility is an acknowledged gap in the current practice: captions and transcripts are not part of the baseline flow and should be integrated in future iterations. This omission represents a significant accessibility gap for learners with hearing impairments that we intend to address in subsequent iterations. Finally, the cost tiers are indicative rather than price-stable, and environmental factors (e.g., intermittent power, variable broadband) can influence throughput in ways that are context-specific. These constraints do not undermine the core contribution—a reproducible, low-cost, high-consistency process flow—but they bound its generalization.

12. Conclusion

This study presented a low-cost, high-consistency process flow for producing YouTube-ready, audio-visual lessons in foundational computer education, designed for a single educator to run end-to-end. The contribution is pragmatic and reproducible: a screen-recording-first pipeline, explicit phase gates from pre-production to quality assurance, stable standardization anchors, a publishing checklist aligned to YouTube's affordances, and a compact risk-control plan that favors fast, binary checks and minimal recovery actions. By freezing decisions that do not need to vary, the workflow channels effort into topic clarity and pacing while keeping technical quality steady across videos.

Within the constraints acknowledged above, the flow scales through batching, asset reuse, and lightweight documentation, enabling higher output without eroding quality. In practice, the approach provides an immediately adoptable blueprint for educators who must operate without a studio team or large budget, particularly in computer education related subjects where screen work predominate. Future extensions—folding in captions and accessibility checks by default, experimenting with alternate export targets, and adding a small analytics loop that informs production choices—can be layered onto the same chassis without changing its low-cost character.

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