Proof reading of an integration problem

Check the following integration steps. Are there any mistakes that lead to the different answers in Method 1 and Method 2?

Method 1

Evaluate $\int \frac{x^2}{\sqrt{4-x^2}} dx$.

We have the standard integral: $\int \frac{1}{\sqrt{4-x^2}} dx = \sin^{-1}\left(\frac{x}{2}\right) + c$.

$$I = \int \frac{x^2}{\sqrt{4-x^2}} dx = \int \frac{4-(4-x^2)}{\sqrt{4-x^2}} dx = 4\int \frac{1}{\sqrt{4-x^2}} dx - \int \sqrt{4-x^2}\, dx$$

$$= 4\sin^{-1}\left(\frac{x}{2}\right) - \left[x\sqrt{4-x^2} - \int x d\left(\sqrt{4-x^2}\right)\right]$$, integration by parts.

$$= 4\sin^{-1}\left(\frac{x}{2}\right) - x\sqrt{4-x^2} + \int x \frac{-2x}{2\sqrt{4-x^2}} dx = 4\sin^{-1}\left(\frac{x}{2}\right) - x\sqrt{4-x^2} - I$$

$$\therefore 2I = 4\sin^{-1}\left(\frac{x}{2}\right) - x\sqrt{4-x^2}$$

$$\therefore I = 2\sin^{-1}\left(\frac{x}{2}\right) - \frac{1}{2}x\sqrt{4-x^2} + C \quad \ldots (1)$$

Method 2

$$I = \int \frac{x^2}{\sqrt{4-x^2}} dx$$

Let $u^2 = 4 - x^2$, $2udu = -2xdx$, $udu = -xdx$

$$I = -\int \frac{\sqrt{4-u^2}}{u} udu = -\int \sqrt{4-u^2}\, du$$

Let $u = 2\sin t, du = 2\cos t\, dt$

$$I = -\int 2\cos t\,(2\cos t\, dt) = -4\int \cos^2 t dt = -4\int \left(\frac{1+\cos 2t}{2}\right) dt = -2[t + \sin 2t] + c$$

$$= -2t - 2\sin t\cos t + c = -2\sin^{-1}\left(\frac{u}{2}\right) - u\sqrt{1-\left(\frac{u}{2}\right)^2} + c = -2\sin^{-1}\left(\frac{u}{2}\right) - \frac{1}{2}u\sqrt{u^2-1} + c$$

$$= -2\sin^{-1}\left(\frac{\sqrt{4-x^2}}{2}\right) - \frac{1}{2}x\sqrt{4-x^2} + c \quad \ldots (2)$$