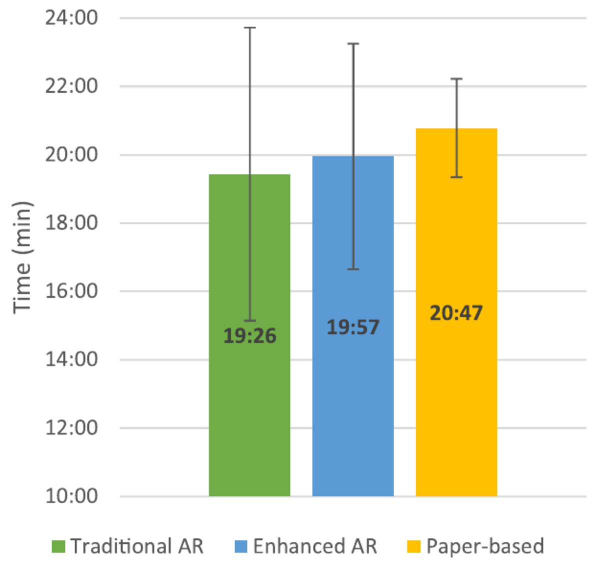

Fig. 4. Mean Task Completion Time.

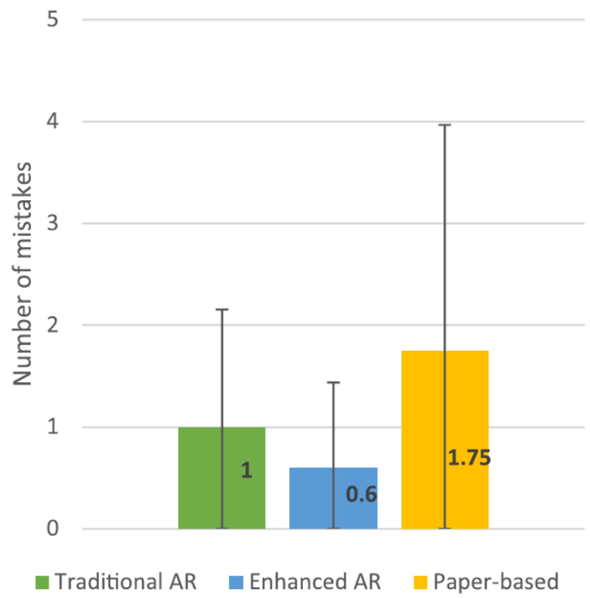

Fig. 5. Mean number of mistakes.

among groups ((F(2,10) = 1.335, p = 0.306).

4.8. Knowledge retention and reusability correlation

The associations between knowledge retention and knowledge reusability along as well as between short- and long-term retention were shown on the Table 6. Point-Biserial Correlation determined that knowledge reusability had a statistically significant positive correlation with short-term retention score (rpb = 0.672, n = 13, p = 0.012), but not for long-term retention scores (rpb = 0.466, n = 13, p = 0.108). However, when knowledge retention between short- and long-term was analyzed, Pearson's correlation showed that there was a positive correlation between both, which was statistically significant (rp = 0.717, n = 13, p = 0.006). Fig. 6 illustrates the comparison for the success rate of wiring a second sensor by comparing the traditional AR, Enhanced AR and Paper based approaches, achieving 50%, 80% and 25% respectively..

Table 6
Knowledge retention scores relative to the baseline.

	Traditional AR group (4 People)	Enhanced AR group (5 People)	Paper-based group (4 People)
ST	* *61.37 %	* *67.27 %	* 43.18 %
LT	* *54.54 %	* *74.54 %	* 40.91 %
LT - ST	-6.83 %	7.27 %	-2.27 %
ST (short-term), LT (long-term)			

*p < 0.05
* *p < 0.01

5. Discussion

Many applications have shown that AR technology can improve learnability when acquiring new skills or concepts over traditional training in terms of knowledge comprehension rate and knowledge retention. The superiority of AR lies in its capability to overlay interactive and animated information in a timely manner. This helps to increase user's motivation to engage with the content which is essential to encourage learning. Besides, allowing users to see the necessary information at a favorable time results in a more efficient use of cognitive resources and in turn accommodates more learning. Nevertheless, the current paradigm in using AR for training seems to focus on a limited aspect of productivity such as task performance and knowledge retention enablement. In the light of Industry 5.0 which emphasizes on human centric, sustainability, and resilience, technology is expected to be developed in ways that serve human needs for upskilling or reskilling, with efficient use of resources, and better equip human to deal with uncertainties [15,31]. In attempt to expand the knowledge in this area, this study sought to base the development of AR system for training on human centric principles to facilitate meaningful learning and achieve improved learnability in terms of retention test and transfer test (see. Table 7).

The results in the retention test showed that all users demonstrated statistically significant understanding in the given task regardless of which training system (see Table 5). However, users in the AR groups were able to get an overall higher number of correct answers (18% for the traditional and ~25 % for the enhanced) than paper-based manual despite completion time and number of mistakes committed were similar across groups. Although the differences were not significant in the short-term test, the higher scores observed in AR groups could be due to more extraneous processing occurred in the paper-based manual group whereas more essential processing occurred in the AR groups. Essential processing involves intrinsic load or essential material/

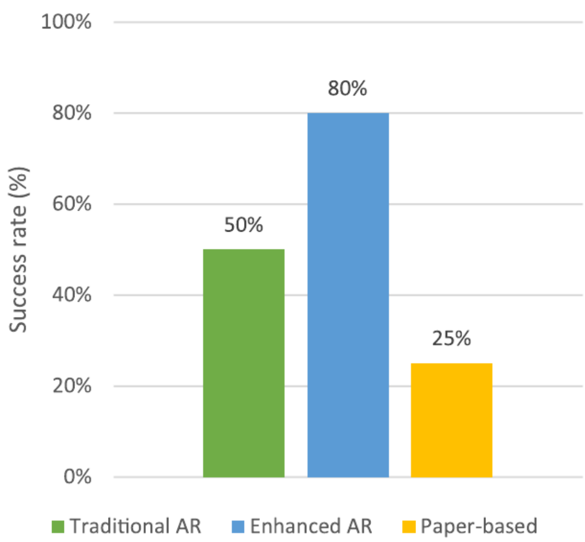

Fig. 6. Success rate of wiring a second sensor.