Identifying effectiveness of different input devices as pointing devices for graphical user interfaces

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ABSTRACT
As new input devices are introduced to the technological market and an increasing part of the population are familiar with the usage of digital devices, it may seem difficult to know which input devices to aim for when developing new programs and applications that use graphical interfaces. According to a previous study in this area, the computer mouse was the most preferred and performed best when tested in speed and accuracy when compared to the keyboard and drawing tablet even though the keyboard was the device most were familiar with. This paper attempted to recreate the study with the exception of testing more things, such as number of miss-clicks, distance travelled, directional changes and time. The keyboard was replaced by a handheld controller as well. The results were that the mouse performed best yet again, and proved to be easy to use efficiently for both new and experienced users. The handheld controller was shown not to be an optimal pointing device, mostly due to it being stuck to a fixed speed and not able to accelerate. It did well in the matter of amount off miss-clicks and directional changes, which can be tied to its slow speed. The drawing tablet was well received by the new users and experienced as more accurate than the handheld device. Its results suggest that the drawing tablet could be an efficient pointing device than proven here in the hands of an experienced user, but for new users it could not perform as well as the mouse device overall.

SAMMANFATTNING
Eftersom nya inmatningsenheter introduceras på den tekniska marknaden och en större del av befolkningen bekantar sig med användningen av digitala enheter, kan det verka svårt att veta vilka inmatningsenheter man ska rikta sig till när man utvecklar nya program och applikationer som användar grafiskt gränssnitt. Enligt en tidigare studie var datormusen den mest föredragen enheten och fick bäst resultat inom snabbhet och noggrannhet, jämfört med tangentbordet och ritplattan inom detta område, trots att tangentbordet var den enhet som de flesta var bekanta med. Denna undersökning försökte återskapa studien med undantaget att testa flera egenskaper, såsom antal missade klickar, avstånd, byten av färdriktning och tid samt att tangentbordet ersattes av en handhållna enheten. Resultatet tyder på att ritplattan kan vara en effektiv pekdon i händerna på en erfaren användare än bevisat här, men för nya användare kan det inte fungera lika bra som datormusen överlag.

Keywords
Input device; computer mouse; handheld controller; drawing tablet; comparison; graphical user interface; pointing device.

1. INTRODUCTION
Graphical user interfaces for computer applications and games are mainly focused at providing the user an interface to interact with graphical components [8]. Doing this usually requires navigating a cursor on a two-dimensional screen and creating some sort of an event (i.e. clicking/touching), often referred to as a pointing device. It’s still possible to navigate with other input devices, such as a keyboard, but this has been shown to be slow [2, 5].

Today the most used input device for graphical applications is the computer mouse, but with new technological advances being introduced everyday it might be time to consider if another device may work better for these cases.

One commonly used device is the handheld controller, that many prefer to use within computer gaming, but not so much elsewhere. The less used drawing tablet is mostly used for photo editing and digital drawing. Are these limited only to their current uses or could they be better integrated in more common usages? This paper aims to test three input devices, the computer mouse, the handheld controller and the drawing tablet, to how well they compare against each other in common tasks for graphical user interfaces.

1.1 Problem definition and purpose
1.1.1 Research question
What is the effectiveness of mouse, handheld controller and drawing tablet within the areas of precision, speed and error proneness in basic graphical user interfaces?

1.1.2 Purpose
An earlier article from 1994 by Coll, Richard [3], answered this question for similar input devices. However, this was done 24 years ago, and technology and its integration in society has changed much since then. Not only are people more affiliated with this type of technology today, but everyday technology has developed with an accelerating speed and there are more choices of input systems today as well. This research aims to confirm
whether their results still holds and to provide useful data which developers can use when designing graphical user interfaces for one of the specified input devices, and for developers to determine which input device to focus their application for.

1.1.2 Delimitation
Some changes to the study were made, with the most noticeable one being that the keyboard was not tested and was instead replaced by the handheld controller. This was due to the keyboard being significantly slower to use than both mouse and drawing tablet, which seems consistent in other research as well [2, 3, 5]. This study does not consider differences in sex either, as this has been shown to have no significant difference [3, 6].

This study chose to focus on hand-steered mechanical input devices, and thus disregard devices such as touchpad, eye-tracking, foot controlled devices and others. This was to both compare devices within a common category, but also to reduce the number of devices to test, in order to cut down time in order to allow the experiments to not take too long time.

2. BACKGROUND
In this section the definition and history of the tested input devices will be given, as well as a short description of the experiment conducted by Coll, Zia and Coll in 1994 [3] and other previous studies.

2.1 Computer mouse
The computer mouse is the first commercially successful analog pointing device. It was invented by Douglas Engelbart of Stanford Research Center in 1964, and was patented as the X-Y Position Indicator [13], before getting the more commonly known name Mouse or Computer Mouse due to the cord looking like the tail of a mouse. [1]

The mouse has seen many changes since it was originally introduced and today it is mostly recognized that a mouse has a right and a left button and a scrolling wheel. Earlier it was common to have a mechanical wheel beneath the mouse to detect motion, which in modern time been replaced by a laser sensor [9].

2.2 Handheld USB controller
The handheld USB controller is a controller that plugs into an USB port. It is a form of gamepad, a type of game controller held in two hands, where the thumbs are used to provide input, used mostly for console and PC-games and often has two joysticks and several buttons. Its movement is based on one or two fixed speeds, and cannot accelerate.

2.3 Drawing tablet
The drawing tablet is an input device that allows for drawing and sketches to be directly entered into a computer. It is made up of an electronic tablet paired together with a pen. The pen is similar to a normal ballpoint pen, but uses a head that can be detected by the tablet that translate the movements into digital signals. The tablet represents the computer screen in a fixed manner with each point on the tablet having a fixed point on the screen, differing to how a computer mouse is used. [15]

2.4 Previous studies
In a study done by Coll, Zia, Coll (1994), a computer mouse, drawing tablet (“pen-on-vertical-screen”) and a keyboard were compared to each other in the sense of speed, accuracy, and preference [3].

That paper may not be as viable today due to the changes done within the fields of these devices and due to their integration into modern society. The study conducted in 1994 does not specify the specification of the used input devices, so it’s reasonable to assume they used devices that have seen significant changes and are evidently not an appropriate indication of the modern versions.

It was believed that the pen would prove to perform better than the mouse and keyboard, however it was found that the mouse had performed best out of the three devices used, despite that only 3 out of 63 users had used a mouse before. The mouse was also most preferred by the testers for general work, but the keyboard was preferred for highly accurate work and the device all the participants were familiar with.

Newer studies have been carried out, although these mainly focus on ergonomics/health [7], ease of use [12], or preference perception. Those who focus on the performance of a pointing device tend to focus on newer technology, such as touch screens. It seems relevant to perform a study focusing on more current devices used today and how effectively they can be used as a pointing device.

In [12], 8 input devices were compared when users played a one versus one game in a 3D-environment, amongst which were a computer mouse and an XBOX gamepad. The mouse and XBOX controller were rated together with 2 other devices easiest to use, and XBOX gamepad was proven one of the most well adapt to the test environment.

A study in 2016 [14] evaluated the mouse against handheld controller (among others) both as a pointing device and in the perspective of usability and user experience. They concluded that the mouse is still the better of those two as a pointing device and in the sense of usability and user experience. The controller performed the worst as a pointing device but was more likeable for game play.

From a study done 2000 [11], a Mouse, digitising pen, accupoint and trackball were tested against each other as pointing devices in a 2D space, and results showed that the mouse and digitising pen did excellent as pointing devices and received similar results.

2.5 Concepts
Input device refers to one of the three devices: mouse, handheld controller or drawing tablet.

Effectiveness refers to how well the devices perform in terms of speed and accuracy.

3. METHOD
Three different experiments were designed based on those done in a previous study [3], each to simulate different actions, and they all were repeated three times each (three “rounds”). The subject tried each input device for 3 rounds for all three experiments. The order of which device each subject started and ended with was randomized to prevent order effects, such as practice effect and fatigue effect [10]. All experiments started with the cursor centered at the screen, and the timing started when the subject moved the cursor. A countdown of 2 seconds was added before each experiment to prevent the subject to accidently move the mouse and start the timer. General observations were made on the participants performances with the devices.
After the experiments each participant were sent an online survey to their mail where they were to rate their previous experience with each input device and which device they preferred for the experiment. They also were to comment for each device what it had done well and what it had done poorly.

3.1 Equipment
Three input devices were used. Logitech G502 Proteus Spectrum Gaming Mouse (the mouse), HUION H610 Pro Drawing Tablet (the drawing tablet) and USB-208 USB 1.0/2.0 Wired Game Controller (the handheld controller).

Each input device had a specific configuration that wasn’t changed between the subjects. The mouse steered the cursor when moved across the table surface, and a click was created when the subject pressed left mouse button. All subjects used the right hand. The handheld controller steered the cursor with the help of its left joystick, using his/her left thumb, and pressed with button number 3 on the right side, using his/her right thumb. The drawing tablet moved the cursor by hovering the pen above the tablet. To generate a click, the users touched the tablet with the tip of the pen.

The experiments were created and run on a Macbook Pro 13 inch from early 2011. They were written in Python 3.6.2 using the external library Pyglet 1.3.1 for reading input and drawing graphics, and they ran at 1/60 second update rate.

All experiments were carried out in a quiet, private room.

3.2 The collected data
There were seven different attributes that were collected by the program to be able to analyse the speed and accuracy.

- **Time** - the average number of seconds it took each user to complete one round.
- **Miss-clicks** - the average amount of clicks that wasn’t within the area expected from the experiment.
- **Precision deviation** - the distance from the clickable areas’ center.
- **Positions** - a list of x, y-coordinates for each update (1/60 second).

Unfortunately, precision deviation weren’t recorded for experiment 1, and miss-clicks weren’t recorded for experiment 2.

The **positions** attribute was recorded in order to calculate other useful data.

- **Distance** - the number of pixels the cursor traveled. Calculated by summing the distances between each recorded position. For diagonal movement, the pixels traveled would be \( \sqrt{x^2 + y^2} \), as according to pythagoras theorem.
- **Speed** - the average amount of pixels the cursor travels (distance) divided by the time for each round.
- **Direction changes** - the number of times the user changed the direction either horizontally or vertically. It’s number of horizontally direction changes is calculated by counting how many times an x-coordinate minus the following x-coordinate changes signs. For vertical direction changes, the same was done using the y-coordinates.

Direction changes, precision deviation and miss-clicks were put in the category **accuracy**, whereas speed and time were grouped into **speed**.

3.3 The experiments
Each experiment tested different areas relating to common activities within graphical user interfaces, namely pointing, clicking, and dragging.

In the first test, clicking and moving was tested to emulate selecting. Each subject used the input device to control a cursor that they were to place over a square and click. Once the square was clicked, it would disappear and a new one appeared at another location. In total each subject pressed 10 squares at different locations. The experiments began with the cursor positioned at the center of the screen and started when they began to move the cursor.

![Figure 1: Experiment 1. Start screen.](image1)

In the second test, dragging was tested to emulate drawing or moving graphical components. The user was presented with several small squares laid out in the shape of a triangle, a rectangle and a pentagon. The subjects were to press on a square and hold the button as they moved over to another square. They then release the button in order to create a green line between each square. For each completed shape, the current would disappear and the next shape would appear until the subject had drawn all three shapes.

![Figure 2: Experiment 2. Experiment being executed.](image2)

In the last test, clicking and moving was tested to emulate picking up and dropping. The subjects had to move a shape into an outline of that shape. The shapes where lines in the form of a triangle, a rectangle and a pentagon. They clicked once while the cursor was over the shape to pick it up, moved it to the outline and clicked the button again to “drop” the shape into the outline. Once a shape had been placed correctly, a margin of error of 10 pixels between
the centres of the shapes, it would disappear and the next one would appear on screen.

4. RESULTS

4.2 Experiment results

The results were analysed using one-way analysis of variance (ANOVA). The figures show graphs with results of the different aspects that were analysed, where the y-axis represents the measurements and the x-axis the experiment. Only results from experiments with significant results are shown.

Figure 3 shows the average number of directional changes between each device for the three rounds. ANOVA showed this to be the most significant ($F(2, 6) = 143.88, p < 0.00001, F(2, 6) = 136.83, p < 0.00001$ and $F(2, 6) = 203.68, p < 0.000001$) difference of all attributes. This was the same through the other experiments as well. The scheffe test showed that the controller changed direction the least, followed by mouse and then tablet (controller < mouse < tablet) for all experiments.

![Figure 3: Experiment 3. Start screen.](image)

Each subject were offered to test out the devices before the actual experiment started, in case they hadn’t tried the devices before, since this paper does not aim to analyze the learning curve of each device. The tests also had sound effects to indicate to the subject if they had done correctly or not. All three experiments (with three repetitions per experiment) all repeated for three rounds took about 25 minutes per subject.

3.5 Participants

A total of 29 students between the ages of 18-30 (estimated) from KTH, Royal Institute of Science Stockholm School of Computer Science and Communication participated in the study.

![Figure 4: The average direction changes for experiments 1-3, for each round. Direction changes represent the number of times the user changed the direction either horizontally or vertically. Significant differences were shown in all three experiments.](image)

Figure 5 shows the average speeds between each device for the three rounds. ANOVA showed this to be a significant difference ($F(2, 6) = 100.42, p < 0.0001$ and $F(2, 6) = 145.36, p < 0.00001$, $F(2, 6) = 15.098, p < 0.01$) for the first two experiments, with a lower significance for experiment 3. The scheffe test showed that mouse was the best (mouse > tablet > controller) for experiment 1 and 2, but for experiment 3 both mouse and drawing tablet where equally fast (mouse = tablet > controller).

![Figure 5: Average speed for experiments 1-2. The speed is represented by](image)
the average amount of pixels the cursor travels divided by time. Significant differences were shown in all three experiments.

As expected (since time and speed are related) the average time (seen in figure 6) between each device for the three rounds were shown to be significant (F(2, 6) = 27.249, p < 0.001, F(2, 6) = 572.851, p < 0.0001, and F(2, 6) = 91.940, p < 0.0001) where experiment 1 had a lesser significance. The scheffe test showed that mouse and tablet took equal amount of time for all experiments, and controller the most time (controller > tablet = mouse).

![Average time in seconds](image)

**Figure 6:** Average time in seconds. The average number of seconds it took each user to complete experiments 1-3. Significant differences were shown in all three experiments.

The average precision deviation (shown in figure 7) between each device for the two experiments (whereas the first experiment, it wasn’t recorded) were shown to be significant (F(2, 6) = 17.443, p < 0.01, F(2, 6) = 27.473, p < 0.001). The Scheffe test showed the mouse to be the most accurate, with drawing tablet and controller being equally accurate (controller = tablet > mouse) for all experiments.

![Average precision deviation in pixels](image)

**Figure 7:** Average precision deviation for experiment 2 and 3 (whereas it was not recorded for the first experiment). The precision deviation is the distance in pixels from the clickable areas’ center. Significant differences were shown in both experiments.

The average miss-clicks (errors) between each device for the two experiments (as for the second experiment, it wasn’t recorded) were shown to be significant (F(2, 6) = 20.756, p < 0.01, F(2, 6) = 24.818, p < 0.01). The mouse had the least amount of miss-clicks for experiment one, where drawing tablet and controller where equal (tablet = controller > mouse), and for experiment three both the mouse and controller performed better than the drawing tablet (tablet > controller = mouse). Results for this can be seen in figure 8.

![Average miss-clicks](image)

**Figure 8:** Average miss-clicks for experiments 1 and 3 (whereas it was not recorded for the second experiment). Significant differences were shown in both experiments.

Figure 9 shows the average distance. There were no significant differences (F(2, 6) = 0.2785, p < 1, F(2, 6) = 9.2335, p < 0.05, F(2, 6) = 0.1686, p < 1) between the devices for experiment 1 and 3 here. However, there was a significant between them in experiment 2, where the Scheffe test showed that both the tablet and controller required more distance than the mouse (tablet = controller > mouse) to complete the task.

The tables presented here show the results of the most significantly differences recorded in each experiment. The first number represents which experiment the data is from, and the second from which round, ie: 1.2 references experiment 1, round 2.

![Average distance in pixels](image)

**Figure 9:** Average distance, where distance is the number of pixels the cursor traveled. Significant differences were shown in all three experiments.

### 4.1 Survey results and observations

28 out of 29 participants answered the survey sent out to them.
two comments on being steady (with the cursor), having smooth movements and doing well on the second and third test. Single comments were made on it clicking small targets, being fast, swapping directions, easy to use, easy to steer and it’s button being easy to press.

4.1.5 Controller - Negative comments
13 of the users complained about the speed of the device. 10 found it hard to move the cursor with the device when not moving in a straight line. 6 of the users didn’t like it’s precision and 2 comments were made on it being hard to hit the targets accurately, drawing lines and it being bad on the third test. Single comments were made on it being bad at the first test, all three tests and at hitting small objects.

4.1.6 Controller - Observations
It was observed that several testers had difficulty using this device, and several complain about it’s speed during testing. This led to most of them adapting to moving the cursor in one direction while trying to stop or hit the button at the correct time when the cursor was over the desired location.

4.1.7 Drawing tablet - Positive comments
13 participants commented on the device being fast, and 10 thought it was precise. 8 users found it good at drawing lines and 4 thought it did well in the third test. 3 comments were made on it being intuitive and easy to use, while one comment was made on it being consistent, comfortable, easy to estimate the cursors movements, sensitive and on being fun to use.

4.1.8 Drawing tablet - Negative comments
4 testers complained about it’s usage during the first test, while 3 comments were made on it’s precision being bad and being unused to the device. 3 users also thought the hovering of the pen to be difficult. 4 mentions were made on the pen reacting to shaky hands and 2 on it being hard to understand the screen-tablet ratio and having to move their hand around too much. Single comments were made on it being fast, difficult to estimate where the cursors position, not being ergonomic, sensitive and it being easy to miss-click if the pen was tilted.

4.1.9 Drawing tablet - Observations
During testing it was observed that several of the users reacted positive initially to using the tablet, even though most of them had no previous experience with it. It was observed that a few users would accidentally hold the pen at a much larger angle than intended which would cause the cursor to go lower when they tried to click a target. When moving great distances with the pen it was also observed that some testers would accidentally touch the surface of the tablet with the pen several times.

5. DISCUSSION

5.1 Mouse

4.1.1 Mouse - Positive comments
14 participants found it’s precision was good and 11 that it had a good speed. 6 found that the mouse did well on everything, and 5 commented on it being easy to control. 4 thought it did well on all the tests. 3 thought it did well in the first task and 2 that it did well in the third task. 2 mentioned being familiar with the device as a positive trait. The devices click speed, accuracy, precise movements, small movements and less prone to miss-clicks got one positive comment.

4.1.2 Mouse - Negative comments
11 of the participants had nothing bad to say about the mouse. 7 users complained about the mouse speed and sensitivity but 3 of these pointed out that it might be because they weren’t used to the set speed. The device got 4 comments on not doing so well when drawing lines. 2 thought the mouse wasn’t as precise as the drawing tablet. One mention was made on the user having to move their hand and forearm too much.

4.1.3 Mouse - Observations
Nothing of value was observed during the experiments where the mouse was tested.

4.1.4 Controller - Positive comments
6 thought it had done nothing well. 5 said it was good at drawing straight lines. 3 thought it was ergonomic. The device received
The results from the tests suggest the mouse to be the best device out of the three overall, only lacking in the area of directional changes, where the handheld controller did better. It also had to change direction more often than the controller, which suggests that it overshoots (goes past the intended stopping/turning point inadvertently) its targets.

According to the survey results, the mouse was the most familiar and most preferred device to the test group (seen in figure 10), with 26/28 users stating that they were “very experienced” with it and 21/28 preferring it to the other two devices. 39% of the group had nothing negative to comment on the mouse. 1/4th of the group complained about the speed or sensitivity of the mouse, but 3 of these thought it might be due to it not being set to their personal preference and may in that case not be as relevant as otherwise suggested. According to the positive comments, the mouse was precise, had a good speed and was easy to use. This could be argued to be due to the testers familiarity with the device, but according to [3], where only 3 out of 63 participants had used a mouse before, it still performed better than the keyboard, even though most of the participants had used the keyboard before. This strongly suggests the mouse device to be easy to use efficiently for both new and experienced users. Study [14] also confirms the mouse to be dominant in performance and preferability.

5.2 Handheld controller
The handheld controller performed best in terms of directional changes, which can also be seen in the survey as well due to it being said that the device had “smooth” movements. Otherwise, it performed poorly in most aspects, speed being it’s greatest hindrance.

The only positive pointers from the survey were that the handheld controller had smooth movements and was easy to use. About half the group had trouble with it’s speed and and it was observed that the users had a hard time moving the cursor to the desired location on the screen and making finer adjustments, something all the comments from the survey seem to confirm.

Over a third of the test group found it hard to be precise with this device, however data suggests that it performed equally as well as the drawing tablet in precision deviation, and had fewer miss-clicks. This may be explained due to the drawing tablet being quite a bit faster than the handheld device, and was thus experienced as more accurate. This could also suggest that the handheld device may have only performed better due to being more familiar to the test group than the drawing tablet. This can be compared to study [12] where it was shown that people familiar with the used input system of an XBOX controller had a small advantage over those were not familiar with their device of choice. The results from figure 8 show that the handheld controller did not receive any votes when the group was asked which device they preferred, which together with the data and comments made suggests that the handheld controller is very inefficient as a pointing device. However, this does not prove it to be a bad input device. According to [14], the controller performs badly at being a pointing device, but could have potential in a game environment, confirmed by [12] as well.

5.3 Drawing tablet
The drawing tablet performed equally as good as the mouse in speed and time, performed equally as well as the controller on precision deviation and in terms of travelled distance. It did not perform best in any of the presented aspects and was the worst amongst the three when it came to miss-clicks and directional changes.

It received a lot of positive comments in the survey, with almost half the group describing it as fast and over a third of them saying it was precise, even though it had the highest miss-click count of the three devices. The comments section suggest this might be due to some of the testers having shaky hands (and possibly not supporting their hands correctly on the surface), which should explain it’s high number in directional changes as well. In the observations it was noticed that when moving larger distances with the pen, some users would accidentally touch the surface of the tablet with the tip of the pen. This is most likely due to inexperience with the device and may have caused it’s miss-click count to be higher than it otherwise would have been.

The ratio between people preferring a device and having used it before was the greatest for the drawing tablet, suggesting that many of the users would be open to use a drawing tablet. These results suggest that the drawing device could be an efficient pointing device in the hands of an experienced user. For new users it was well received but did not perform as well as the mouse device. In another study, [11] the mouse and digitizing pen were shown to have very similar results and thought to be great pointing devices, which supports the results of this study somewhat.

5.4 Method critique
There were a few bugs in the program created for the tests, which caused minor problems for about one third of the test group, causing them to have to repeat the last step of some of the tests. This will have affected their time by adding to how long it took them to finish the test. These may also have added slightly to the click- misclick ratio and the distance moved due to the test being longer than intended. There was one bug in the program that led to data not being recorded for the first few tests. This was counteracted when calculating the average, which was based on the number of subjects the data was recorded from. Since it isn’t always a solid 29 subjects, this was taken into account when doing the each calculation for each mean and have been corrected. Nothing else was changed or corrupted by any means.

Mouse sensitivity is very personal, and thus the mouse controllers speed was experienced differently among the testers. Only one speed was programmed for the handheld controller as well, when in most functions/games it has two, which made it badly adapted to all the tests. Testers experienced it as too slow for the first test, and too fast for the second and third one. The quality between the devices varied as well. The drawing tablet was a higher quality, professional device, whereas the handheld controller was low quality, hobby controller. The mouse was about average quality. This will have affected speed and movement the most. The mouse was used without a mouse mat since the table used was deemed appropriate to use without one, which may have affected mouse precision slightly.

6. CONCLUSION
As it stands, the mouse is still the most dominant input device. It is both faster and often more accurate, and most preferred which is in line with study done by Coll [3]. Comparing to his study, a clear conclusion can be drawn that the mouse device could be efficiently used by new and more experienced users. The
handheld controller was proven not to be an optimal pointing device, due to it being stuck to a fixed speed, whereas the mouse and drawing tablet could accelerate the cursors speed when in use. It was however easier to minimize number of directional changes with the handheld controller device. The drawing tablet was the device users had least experience with, yet one fourth of the test group preferred it to the other devices. It was experienced as more accurate than the handheld device. The results suggest that the drawing tablet could be an efficient pointing device in the hands of an experienced user, but for new users it could not perform as well as the mouse device. This suggests that further research should be made with more experienced users of the drawing tablet, or a test group that learn to use it over a period of time to further study the effectiveness of this device.

7. FURTHER RESEARCH

There are several things that could be extended to this study, such as evaluating other characteristics between the input devices, including ergonomics, health, price, learning curve and more. This study also didn’t follow any accepted ISO standards (ISO 9241-9) for testing computer pointing devices [4], which could be a discred to the study. Further research should be made on the effectiveness of the drawing tablet as a pointing device with users who are more experienced with the device or allowed to learn to use it over a period of time due to its promising results.

8. ACKNOWLEDGMENTS

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9. REFERENCES


APPENDIX A - The experiments

Experiment 1

Move the cursor to start

Experiment 2

Can start at 1.5 s

Move the cursor to start