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THE ONLINE CLASSROOM EXPERIENCE: GAMIFICATION WITH GATHER.TOWN VERSUS CONVENTIONAL VIDEOCONFERENCING PLATFORMS

MA thesis

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Abstract

With the onset of Covid-19 learning had to move online, which introduced a variety of new challenges for both teachers and students. A potential answer that attempts to bridge the distance learning gap is Gather.Town, which gamifies videoconferencing. In this study a comparison between Gather.Town and Zoom was made on primary and high school students, as well as educators, in an extracurricular setting. The User Experience Questionnaire and its benchmark were used to compare the platforms. Most students and educators found Gather.Town more attractive and stimulating than Zoom, although not necessarily more dependable and efficient. Gather.Town generally enhances the learning experience, however, it could not be established that this translates into improved academic performance.

Keywords: Gather.Town, online learning, extracurricular, distance learning, videoconferencing.

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Introduction

The start of the Covid-2019 pandemic in early 2020 forced many schools and universities across the world to close their doors to physical classrooms and lecture theatres and in haste make plans for their teaching staff to interact online with their students. This abruptly changed the teaching atmosphere for many teachers as well as students, going from the formal classroom setting to home offices, living rooms or often even just bedrooms.

This development introduced a variety of new challenges for both teachers and students. While a teacher in a formal classroom setting can observe the non-verbal cues of students, this becomes more difficult in an online setting. This can be further complicated by hardware requirements: some students might lack working microphones and/or cameras or even just sufficient bandwidth to enable joining with a camera. In other cases students might even opt to not switch a working camera on due to an embarrassment factor (Castelli & Sarvary, 2021). This all culminates in the situation that teachers might be lecturing into a void.

Apart from all of the technology challenges, students might also find it more difficult on a psychological level. Research has identified a phenomenon termed ‘Zoom Fatigue’, which describes the situation where people get more exhausted during online videoconferencing than they would in a physical setting (Bailenson, 2021). This has a consequence that the normal school day cannot just be converted into online classes of the same length without running into this phenomenon.

The key to solving some of these problems of online lectures may lie in the choice of online platform with properties catering to a specific need. There are a variety of platforms available. A lot of them can be grouped together under the label of conventional videoconferencing platforms: these include software such as Zoom, Google Meet and Microsoft Teams. In addition to those, some non-conventional platforms also exist, which can range from platforms with simply a few added features, repurposing online multiplayer games or social virtual reality (Li et al., 2021).

One of these non-conventional platforms is Gather.Town, where participants create avatars for themselves. These avatars can explore a two-dimensional world and interact with objects. Videoconferencing is enabled between participants when their avatars are sufficiently close to each other in the virtual world. They would be able to hear and see each other as long as their avatars stay sufficiently close to each other. This allows it to be used for online classes. Additionally, the option to walk around with an avatar adds a dimension similar to a

physical environment. Gather.Town is a very recent addition to videoconferencing platforms, having only been launched in May 2020 (*About Gather*, n.d.). Therefore only a limited amount of research has been done involving Gather.Town and hence more is needed.

This thesis aims to investigate how Gather.Town through gamification of the online classroom experience compares to conventional videoconferencing platforms. To this end, the main research question of this thesis is: Do the features of Gather.Town that distinguish it from a conventional videoconferencing platform enhance the learning experience among students aged 12 to 16 in an extracurricular setting?

This study is a quasi-experimental design based research study and builds on existing literature to fill some research gaps that were identified in the literature review. It gives extra validation to some other research studies and brings in a new perspective. It extends insight into Gather.Town from the formal education setting to the informal extracurricular settings.

This study is organised as follows: The second chapter, which is the theoretical overview, defines some key concepts, gives an extensive literature review, introduces the theoretical framework the study is based on and states the aim of the study by defining the research problem with the main research question and formulates the additional research questions to aid in answering the main research question. The third chapter, method, describes the methodology including the design, instruments, sampling procedures, development of materials and the ethical considerations for the main study as well as the supplemental study. The fourth chapter, results, presents the quantitative and qualitative data collected for this study. The fifth chapter, discussion, discusses the results and limitations of the study and answers the research questions.

Theoretical overview

Key concepts

Before moving to the literature review, a few key concepts are highlighted. Some of these concepts may be seen as self-explanatory, but are formalised regardless, since these concepts are mentioned during the literature review.

Gamification

According to the Merriam-Webster dictionary (*Dictionary by Merriam-Webster*, n.d.), gamification "is the process of adding games or gamelike elements to something (such as a task) so as to encourage participation" (*Definition of Gamification*, n.d.).

Gather.Town

Gather.Town is a videoconferencing platform where each participant creates for themselves a virtual avatar, which can then walk around in a two-dimensional world and interact with objects. These objects range from classroom and office furniture to games and holiday decorations and interaction can be as mundane as sitting on chairs around a table or as interactive as drawing on a whiteboard or playing games in a group. Furthermore, participants can also add objects to the classroom environment, if allowed. For these reasons Gather.Town adds gamification to a videoconferencing platform.

When the avatars of participants are sufficiently close to each other in the virtual world, videoconferencing is enabled between them and they can hear and see each other as long as their avatars stay sufficiently close to each other. The 'sufficiently close' can also be manipulated by the creator of the map who can designate certain areas as private spaces where everyone in that private space can hear and see each other. These private spaces can range from a single tile, a pair of tiles, a whole classroom or even the whole map. This allows it to be used for online classes. Additionally, the option to walk around with an avatar adds a dimension similar to a physical environment (Latulipe, 2021).

Gather.Town offers template maps to create spaces for various needs or the option to custom design a brand new map for one's new space with the helpful aid of the Mapmaker interface (Latulipe & De Jaeger, 2022). An important feature of Gather.Town is that there is a limit on the number of participants that can simultaneously join a space for free. This maximum limit is set at 25 participants and events which require more than 25 participants in

the space simultaneously need to subscribe to one of their priced packages either at an hourly, daily or monthly rate (*Gather Pricing*, n.d.).

Conventional videoconferencing platform

In their article about social virtual reality, Li et al. (2021, p. 2) wrote:

> Video conferencing tools, such as Zoom and Google Hangouts, are low-cost, allow multiple users to have conversations at the same time, and provide face-to-face-like experiences compared to audio-only phone calls. Some high-end video conferencing systems such as HP Halo and Cisco Telepresence are designed to link two physically separated rooms through wall-size screens, high-fidelity audio and video, which enable users to feel co-present in a single conference room. However, all the video conferencing tools still restrict users in front of screens with "talking heads experiences", and limit physical activities that naturally arise from social interactions and spontaneous collaborations.

They continue and report that social virtual reality might improve social interaction more than videoconferencing, listing some reasons and social virtual reality platforms. Thereafter they mention that "Platforms like Mozilla Hubs, Gather Town also enable social experiences, but result in dramatically different experiences" (Li et al., 2021, p. 2).

Singh and Awasthi (2020) point out that platforms like Zoom, Google Meet and MS Teams have almost the same features with some exceptions. A similar argument is made by Najjar et al. (2022) where they refer to Zoom, Google Meet and WebEx as 'traditional' videoconferencing platforms and Gather.Town as 'non-traditional'. Furthermore, McClure and Williams (2021) also make a distinction between Gather.Town and other videoconferencing platforms in their study. They point towards this distinction being that Gather.Town is a proximity-based videoconferencing platform, while the others they are comparing it to are not. Hence this study will refer to the collection of Zoom, Google Meet and MS Teams and similar videoconferencing platforms as conventional videoconferencing platforms.

Literature review

Introduction

In order to investigate whether there is a research gap concerning the comparisons of conventional videoconferencing platforms with Gather.Town, which gamifies the classroom and learning experience, a study of the available literature was done. Since Gather.Town was only launched in May 2020 (*About Gather*, n.d.), the search was limited to articles published after May 2020 and hence a narrow window of approximately two years. Therefore it seemed

unlikely that a lot of research articles had been published concerning Gather.Town, if any, since running research experiments and publishing the results of such research takes time and hence an attempt was made to find all available research articles on Gather.Town.

A search for the keyword Gather.Town was done on academic journal databases like Google Scholar. The articles and other research found on Gather.Town were examined and the references to these were checked to determine if they might contain other research on Gather.Town that had not already been found and the process was repeated on any newly found sources. After this process was exhausted, two master's theses (Tu, 2022; Wijnstra, 2021), one conference poster (Latulipe, 2021) and seven articles (Fisher et al., 2021; Fitria, 2021; Latulipe & De Jaeger, 2022; Li et al., 2021; McClure & Williams, 2021; Najjar et al., 2022; Samiei et al., 2020) were found. Although there is still a chance that some Gather.Town research might have eluded this search, which would especially be the case if it was not published in English, the search was extensive enough to be able to identify research gaps.

Ages of participants

The master's thesis of Tu (2022) from the University of Waterloo conducted research on one of the most diverse age groups. The master's thesis was done on 67 adults from around the world (North America, South America, Europe and Africa) between the ages of 18 and 61 with a mean age of 35.71 and they were paid $10 for their efforts. In contrast, the master's thesis of Wijnstra (2021) from the University of Groningen conducted research on 140 first year university students attending the Spatial Design Atelier course.

The conference poster of Latulipe (2021) also concerned first year students, but only described the Gather.Town classroom designed for the 160 first year computer science students at the University of Manitoba. However, no research had been conducted on the course at that point, but they were in the process of starting research. Their conference article presented a year later reported the research on the first year computer science course which consisted of 120 students (Latulipe & De Jaeger, 2022). At the same conference, Najjar et al. (2022) also reported research done on computer science students, but the age range was slightly bigger as it consisted of students in five different courses ranging from first year to fifth year computer science students with student numbers ranging from 25 to 135 per course.

McClure and Williams (2021) from Queen's University Belfast ran a study on 38 fourth year agricultural technology students who were "traditionally considered 'technologically challenged'" (McClure & Williams, 2021, p. 2) as well as the 5 presenters of

the course. In contrast to the previous studies, Fitria (2021) did a research study consisting of one observation of a student, probably in high school, in an online English class.

Two (Fisher et al., 2021; Samiei et al., 2020) of the remaining three articles concerned a review of the experience of organising workshops for academics and scientists on Gather.Town due to the Covid-19 pandemic cancelling the in-person events. Hence the people attending these workshops held on Gather.Town were older than undergraduate students. The final article (Li et al., 2021) only mentioned Gather.Town as a possible platform for hosting workshops, but held their workshop on another platform.

It was therefore seen that a research gap concerning younger students existed, as only one of these studies (Fitria, 2021) might have involved research involving participants who had not yet graduated from high school and the study only consisted of one participant. Thus conducting research on students aged between 12 and 16 with respect to Gather.Town was needed.

Educational setting

Apart from one designed study (Tu, 2022), which used recruitment through randomised sampling from social media posts of a research lab at the university as well as the online platform www.userinterviews.com (*User Interviews | The User Research Recruiting Platform for Teams*, n.d.), the other designed studies (Fitria, 2021; Latulipe & De Jaeger, 2022; McClure & Williams, 2021; Najjar et al., 2022; Wijnstra, 2021) were conducted on students enrolled in a course at an educational institution, mostly university courses. However, McClure and Williams (2021) conducted the study on both students as well as educators. In addition there were also two reviews (Fisher et al., 2021; Samiei et al., 2020), where the setting was an academic workshop or conference. Hence most of the studies were done in a formal education setting and hence more investigation was definitely needed concerning a voluntary extracurricular education setting.

Measurements of the studies

Another important question was what the studies involving Gather.Town measured and of key importance was whether the studies only measured the enhancement of the learning environment or whether studies also measured the performance in educational outcomes.

Tu (2022) conducted research in comparing videoconferencing platforms with respect to audio, video and avatars as part of a master's thesis to investigate the impact on

communication. The study used Gather.Town as the videoconferencing tool featuring avatars. The study only involved participants creating an avatar, joining the Gather.Town session and then following instructions to turn cameras off or on, going to a specific room in the Gather.Town environment, playing charades or telling two minute personal stories in order to test communication in terms of audio, video and avatars. Hence, the study was purely about the communication aspect and didn't involve evaluating Gather.Town as a learning environment nor whether it improves performance in educational outcomes. The study found that there is "no difference in terms of engagement" (Tu, 2022, p. 70) between the different combinations of audio, video and avatars that were tested. However, it was noted that participants who had a gaming background were more inclined to prefer the Gather.Town platform.

Wijnstra (2021) investigated how creativity in Gather.Town compared to creativity in physical spaces in an educational setting as part of a master's thesis. The study measured both the learning environment as well as the performance in educational outcomes. Although it was concluded that creativity is best experienced in physical spaces rather than online on Gather.Town, it was proposed that future research be done comparing Gather.Town to other conventional videoconferencing platforms as there was a bias towards physical spaces. However, the advantages were summarised as "the students valued the visual aspect of GatherTown, the possibility of having one-on-one conversations, the possibility to come together, and the accessibility to the teachers the most" (Wijnstra, 2021, p. 44).

As for the other four studies that were conducted in an educational classroom setting, one of these studies (Latulipe & De Jaeger, 2022) ran an experimental design study comparing Gather.Town to a conventional videoconferencing platform, specifically Zoom, by organising the two 75 minute class sessions per week to be such that one of them was in Gather.Town and the other was in Zoom. This is in contrast to the other three studies (Fitria, 2021; McClure & Williams, 2021; Najjar et al., 2022), which only focussed on gathering data from educational sessions held in Gather.Town, but asking students to compare their experience in Gather.Town during the designed course to other courses they attended in the past that were held on conventional videoconferencing platforms.

Latulipe and De Jaeger (2022) report that students in the first year computer science course gave overall positive feedback on Gather.Town in their experimental design study, mentioning that some of the reasons they strongly preferred GatherTown were "support for peer socialising, sense of place, agency, engagement, and fluid of interactions" (Latulipe & De Jaeger, 2022, p. 411). The study only focussed on measuring the enhancement to the

learning environment by using Gather.Town and didn't mention measuring the impact of the different platforms on academic performance.

In contrast, the other study run on computer science courses (Najjar et al., 2022), mentions that they focussed on measuring the enhancement of the learning environment as it pertains to student satisfaction, but didn't measure the impact on academic performance as measured by grades. However, they hint that the latter should also be investigated.

On the other hand, McClure and Williams (2021) focussed on Gather.Town in comparison to MS Teams, but only organised training sessions in Gather.Town and asked students to compare their experience with prior experience in MS Teams. Furthermore, they point out that they had to split the group of 38 into two groups of 19 for classes, so as to stay below the Gather.Town maximum limit for free participation, which is 25. They did a study on measuring the enhancement to the learning environment and found that both students and educators prefer Gather.Town to conventional videoconferencing platforms. They further report that "this study indicates that the primary advantages of GT are its ability to support tailored and self-paced learning, enabling students to interact with educators on a more informal basis, and the opportunity to use the designed resources in an individualised manner" (McClure & Williams, 2021, p. 8). They make no mention of measuring the impact on academic performance.

Lastly, the two articles reviewing the workshops for academics and scientists (Fisher et al., 2021; Samiei et al., 2020) only report on the enhancement of the experience using Gather.Town and were not in a setting where academic performance is of importance. Therefore only one study (Wijnstra, 2021) measured anything related to measuring the enhancement of academic performance in relation to different Gather.Town versus another classroom setting. This measurement specifically concerned creativity and was also a comparison between Gather.Town and physical spaces, which meant it was not significant in a comparison between Gather.Town and conventional videoconferencing platforms with respect to enhancement on academic performance. Thus, another gap in the research was whether gamification by using Gather.Town could enhance the training experience with respect to academic performance.

Psychological and technical aspects

Another line of research was prompted by Bailenson (2021) who investigated the term 'Zoom Fatigue' which described the experience of users of online videoconferencing platforms,

specifically investigating Zoom, getting more exhausted in comparison to the same time spent in physical meetings. The investigation was based on academic theory and research, but was not field tested with Zoom. The article expressed the wish for others to run research to field test the hypothesis derived from theory. It was concluded that the reasons for exhaustion were caused by design flaws with Zoom, considering elements of visual overload from staring at pictures of people on a screen and of oneself.

Other conventional videoconferencing platforms offer the same features, while Gather.Town distracts from this by also offering avatars that can move around by walking or running around a 2-D map potentially entering and exiting different rooms and spaces, depending on the design of the particular map for the educational session. However, whether this will relieve the effects of 'Zoom Fatigue', which is still to be field tested, is yet another question for research to answer.

Furthermore, Castelli and Savary (2021) conducted research into why video cameras were not switched on during online classes. Some of these reasons included hesitancy about physical appearance or physical background, as well as technical issues. Gather.Town offers participants a chance to design their own avatars which can be an alternative presence to joining with video and hence may be a partial answer towards solving the hesitancy about physical appearance and physical background.

Apart from the psychological, technology can also play a part in the comparison between Gather.Town and conventional videoconferencing platforms. As already mentioned, Castelli and Savary (2021) found technical issues also contributed to students not switching on video cameras. Samiei et al. (2020) commented that although Gather.Town was the top choice for holding poster sessions for a virtual workshop in 2020, there were many participants who complained that they were having technical difficulties, even though it was noted that "Gather.town was a very joyful environment for both presenters and attendees" (Samiei et al., 2020, p. 6).

Roth et al. (2021) reported on where the psychological meets the technological and found that learning and teaching via Zoom, and hence conventional videoconferencing platforms, also lead to too much familiarity among participants with each other's personal appearance. They conclude that this might not be desirable. Since Gather.Town uses small video blocks when moving around the space and communicating with others, it could potentially have less of an impact. However, this impact might not be reduced during sessions where participants maximise the video feed of the presenter. Research to investigate this more thoroughly is still needed.

Conclusion

Although very little research has been done on Gather.Town at this stage and more should be done, specific research gaps that have so far not been touched concerns students aged younger than 18, students participating in an educational setting on an extracurricular basis and whether gamification by using Gather.Town could enhance the training experience with respect to academic performance. Furthermore, only one of the studies tested the enhancing of the learning experience as perceived by educators. Hence there also existed a research gap with respect to the educators. Lastly, additional research gaps existed with respect to psychological and technological impacts of Gather.Town on for instance 'Zoom Fatigue', personal appearance factors and connection issues.

Research problem

The objective of the research problem in this thesis was to expand the current knowledge base of Gather.Town. This was done by investigating how Gather.Town through gamification of the online classroom experience compared to conventional videoconferencing platforms. The main research question of this thesis is: Do the features of Gather.Town that distinguish it from a conventional videoconferencing platform enhance the learning experience among students aged 12 to 16 in an extracurricular setting?

Additional research questions investigated in this thesis that aim to answer and/or augment the main research question are:

1. Is there a preference for Gather.Town over conventional videoconferencing platforms in an extracurricular setting?
2. Does a preference for Gather.Town over conventional videoconferencing platforms lead to an improvement of results in the extracurricular setting of competition mathematics?
3. Is there a difference between the experiences of upper primary school students (grades 6 and 7) and junior high school students (grades 8 to 10)?
4. Do mathematical Olympiad coaches believe the gamification features of Gather.Town enhance the learning experience in a competition setting?

Theoretical framework

This research study used a mixed methods approach, since it used both quantitative and qualitative research. Hence this research study was based in the positivist paradigm as well as the interpretive paradigm (Terre Blanche & Durrheim, 2007). Since qualitative data gathered was analysed with inductive methods due to a subjective relationship that existed between the researcher and the respondents of the qualitative data, the study was partially based in the interpretive paradigm. Furthermore, it was also based in the positivist approach since deductive methods were used to analyse quantitative data gathered from quasi-experimental design to test hypotheses related to the research questions (Terre Blanche & Durrheim, 2007). The study used quasi-experimental design since using random sampling was not an option for this research study (Tredoux & Smith, 2007).

Method

In order to answer all the research questions, two studies were conducted. The original envisioned study was termed the main study. A supplemental study was done to answer the fourth additional research question, since this could not be answered from the main study.

Quasi-experimental design of main study

Since a research gap was identified concerning students that are in school and not yet at university, students aged 12 to 16 would be targeted for the study. Furthermore, since the research question is about learning in an extracurricular setting, students receiving coaching for mathematical competitions would be targeted. The research study focused on a quasi-experimental design as the sample from the population of mathematical competition contestants was not going to be a randomised sample (Tredoux & Smith, 2007).

Furthermore, in order to compare and contrast the learning experience between Gather.Town and conventional videoconferencing platforms, a conventional videoconferencing platform had to be chosen and compared to Gather.Town in some way. Zoom was chosen as the conventional videoconferencing platform. In order to compare and contrast, a few different designs were considered.

Design 1

The first possible design would include two high school classes of students in grade 8 and grade 9 and two primary school classes of students in grade 6 and grade 7. These would either be two classes at one high school or one class each at two different high schools, and similarly for the primary school section.

The reason behind this design was so that one group would get taught in Gather.Town while the other group would be taught in Zoom in each of the two age groups. Furthermore, the number of students in each class was to be 24 or as close to 24 as possible. However, the maximum number could not exceed 24 as that is the limit of Gather.Town's free package (*Gather Pricing*, n.d.). This design would allow the two groups in each age level to be compared and contrasted as well as the age levels to be compared and contrasted.

Design 2

The second possible design would include one high school class of students in grade 8 and grade 9 and one primary school class in grade 6 and grade 7. This would require less organisation as only one class at only one high school and one primary school would be needed.

This design would allow age groups to still be compared and contrasted. However, to allow for comparisons between Gather.Town and Zoom, the coaching sessions would need to oscillate between Gather.Town and Zoom. The oscillation between Gather.Town and Zoom would be a similar setup to that used in the study of Latulipe and De Jager (2022). Hence, this design was indeed valid as it had been used before and could be compared and contrasted. Similarly to design 1, the maximum number of students per group could not exceed 24.

Final design

Due to practical considerations, both design 1 and design 2 had to be partially abandoned as the targeted schools were not keen with the idea of online classes as they rather wanted to have their students attend in-person classes. However, the comparison setup with Gather.Town and Zoom made holding classes online a requirement. Fortunately an alternative was found, in a non-profit organisation JIMCOBSA (Junior International Mathematics Competition Organising Body for South Africa), who normally organise their activities online as they cater to primary and high school students from across South Africa.

The idea behind design 2 of oscillating the coaching sessions between Gather.Town and Zoom was decided upon and the population of JIMCOBSA students would be used to draw a sample from in order to put groups together in a combination of design 1 and 2. In other words, the coaching sessions would oscillate, but two high school groups and two primary school groups would be created, since the JIMCOBSA population was deemed big enough. However, a slight adjustment was made to the grades of the high school students due to the structure of the JIMCOBSA population, which consisted of grade 8 to grade 10 students for high school. Therefore the coaching groups for high school were adjusted to grades 8 to 10 rather than grades 8 and 9.

The final design therefore matched Latulipe and De Jager (2022) rather closely as both would teach two classes per week, with one class being in Gather.Town and the other class being in Zoom. The classes also almost matched in session length as Latulipe and De

Jager (2022) had classes of length 75 minutes and this research study had classes of length 60 minutes. However, this research study only had a total of 6 classes per group.

Instruments of the main study

The advantage of drawing a sample from the JIMCOBSA students was that all the students wrote the first round of a test called the International Mathematics Assessments for Schools just before the commencement of the study and hence this test could act as a pre-test. Furthermore, directly after the end of the study the students were to write the second round of the International Mathematics Assessments for Schools. Therefore this could act as a post-test and hence a natural pre-test and post-test would be in place.

Literature was consulted in order to find a suitable measuring instrument in the form of a questionnaire in order to test the preferences of the students between Gather.Town and Zoom. The articles about Gather.Town were consulted on which data collection procedures they used. The questionnaire used by Wijnstra (2021) was deemed as not relevant as his study compared Gather.Town to physical spaces and was measuring levels of creativity. The questionnaire used by Tu (2022) was in line with what this study aimed to measure and was seen as a possibility. Although the quasi-experimental design closely resembled that of Latulipe and De Jager (2022), they did not publish their instrument as part of their article. The two reviews about online workshops held for academics and scientists (Fisher et al., 2021; Samiei et al., 2020) didn't publish their instrument of data collection either. Although Fitria (2021) did publish the instrument used, since that study only used data collection from one observation, it was deemed not applicable. Both the studies done by McClure and Williams (2021) and Najjar et al. (Najjar et al., 2022) included their data collection instruments, although neither was deemed as satisfactory enough to just use without any more investigation and searching for potentially more appropriate instruments.

After a further literature review for potential instruments of data collection a study by Schrepp et al. (2017) was discovered in which they describe a benchmark that was constructed for the User Experience Questionnaire. They point out that the product and benchmark was developed to specifically compare different software. This comparison can either be done between two different software packages, between a software package and its update or between a software package and a benchmark. They argued the benchmark was valid since "The benchmark currently contains data from 246 product evaluations using the UEQ" (Schrepp et al., 2017, p. 42) and continued to mention that it contained 9905 responses

with sample sizes ranging between 3 and 1390. Furthermore, it was available in 17 languages and hence it was widely used. Therefore this instrument passed the checklist test that Cresswell (2012) outlines in his book about how to conduct good quantitative and qualitative research. Furthermore the User Experience Questionnaire also came with data analysis tools, including a comparison of scale means tool developed by Dr Martin Schrepp, which analyses the User Experience Questionnaire (*User Experience Questionnaire (UEQ)*, n.d.)

Since the User Experience Questionnaire was such a well recognized instrument it was decided to use it as the main data collection tool. Section 1 of the questionnaire consisted of the User Experience Questionnaire, which asked participants to evaluate Zoom on 26 items structured as a 7-point Likert scale. Section 2 consisted of the same 26 items but asked participants to evaluate Gather.Town.

Ethical considerations for the main study

Since the participants involved in the main study were aged between 12 and 16, a consent form was drafted that needed to be signed by parents. The consent form asked parents to give permission for their child to participate in the study. Furthermore, the consent form informed them that participation in the study was voluntary, that they could withdraw at any time and that all information provided for this study would be treated confidentially and that no names or personal information would be disclosed during reporting on the data collection.

Sampling for the main study

Sampling was done from the population of JIMCOBSA students. Around 500 primary and high school students from across the whole of South Africa registered at the start of 2022 to take part in JIMCOBSA activities. However, only 392 wrote the first round of the International Mathematics Assessment for School, which was to be used as the pre-test. Therefore only these 392 were considered when sampling. Since random sampling was not an option and hence the study would be based on quasi-experimental design (Tredoux & Smith, 2007), other sampling methods had to be considered. Convenient sampling was the only option as it was the easiest and best method to advertise the study to all 392 and enrol respondents who were willing and available to participate in the study (Cresswell, 2012).

Since the population of 392 was rather big, the plan was to run the main study on four groups: two primary school groups (aged 12 and 13 in grades 6 and 7) and two high school groups (aged 14-16 in grades 8-10) each consisting of 24 participants, since GatherTown only

offers free participation for 25 or less participants (*Gather Pricing*, n.d.). Each group would receive 6 classes: 3 classes in Gather.Town and 3 classes in Zoom.

The Gather.Town vs Zoom study was advertised by email to these 392 as a research study that for ethical considerations would require parental consent. The coaching sessions were advertised as free of charge in order to not discourage anyone from applying. It was also noted in the email what the dates of the 6 coaching sessions would be and noted that participants should be willing and preferably available for all 6 the coaching sessions, since space was limited.

Although there was space for 96 participants in the study, only 87 applications were received. However, 14 of these applications had to be rejected due to not meeting a certain criteria. The most common criteria not met was the age range, as a lot of grade 4 and grade 5 students applied and hence aged 10 and 11. Other criteria not met included that they did not write the pre-test as they heard of the study from a friend, parents did not give consent or that they were not available for the dates of the coaching sessions but hoped to be accepted into the study and get video recordings of the coaching sessions. As for the latter, respondents as well as the final participants in the main research study were all informed that for ethical reasons the coaching sessions could not be recorded and made available as the coaching sessions were part of a research study.

Due to lack of applications only one primary school group was created containing 25 participants. Even though the aim of the study was to have 24 in the group, since that is Gather.Town's maximum limit, it was suspected that at least one of the participants might drop out of the study before the study commenced and having a group of 25 would not be problematic. There were two high school groups each with 24 participants invited.

Data collection for the main study

Each group had 6 coaching sessions, 2 coaching sessions per week. In each week there was one Zoom and one Gather.Town coaching session. An attendance register was kept for each coaching session. Although in total the coaching sessions took place in 3 different weeks, there was a school vacation break between the first two weeks and the third week. Hence the sessions spanned over a total of 5 weeks in March and April 2022.

During the last 10 minutes of the 6th coaching session participants were asked to complete the questionnaire. This was an attempt to maximise the number of respondents to

the questionnaire, since it was easier to spend a little time at the end of the last coaching session on this than for the participants to motivate themselves to do this at some other time.

However, participants who didn't submit the questionnaire during this time were requested by email after the session to still submit the questionnaire and a follow-up email was sent a while later in order to get more respondents. The data collection for the pre-test was done before the commencement of the coaching sessions. The post-test was written in the two days following the last coaching session and the data for the post-test was collected.

Supplemental study

Since the main study was a quasi-experimental design study envisioned to be conducted on primary and high school students, it had no opportunity to also include data collection from educators. However, one of the identified research gaps was what the perspectives of educators are in comparing Gather.Town with conventional videoconferencing platforms. A few months before the commencement of the main study, an opportunity presented itself to gather data in a supplemental study from educators, specifically mathematics Olympiad coaches. This was due to the South African Maths Olympiad Camp taking place annually in December shifting online and onto Gather.Town.

The supplemental study was to use a mixed methods approach with both quantitative and qualitative data in the form of a survey and therefore both a positivist deductive approach for the quantitative data and interpretive inductive approach for the qualitative data (Terre Blanche & Durrheim, 2007). Sampling was done as convenience sampling on a willingness basis (Cresswell, 2012) from the 9 educators/coaches who lectured at the camp. The instruments to be used for the questionnaires had already been identified through the literature review for the main study. The survey from McClure and Williams (2021) were the most appropriate as that survey was also administered to educators and they reported on the findings and hence a comparison would be possible. Therefore using this instrument was a valid choice. Furthermore, the User Experience Questionnaire was also included as an instrument as it was also a respected instrument (Schrepp et al., 2017). Section 1 of the questionnaire consisted of the survey from McClure and Williams (2021). Section 2 of the questionnaire consisted of the User Experience Questionnaire, which asked coaches to evaluate Zoom on 26 items structured as a 7-point Likert scale. Section 3 consisted of the same 26 items but asked coaches to evaluate Gather.Town.

Materials for the studies

Although Gather.Town offered template maps for various needs, none of the templates offered by Gather.Town was deemed appropriate to the context of the envisioned coaching, which was set in the extracurricular setting of competition mathematics. Since the main advantage of Gather.Town was supposed to be that it could enhance the learning experience through gamification, it was decided that the Gather.Town space should reflect elements representative of competition mathematics and therefore a custom designed map had to be developed with the helpful aid of Mapmaker before the commencement of the research experiment.

A perfect opportunity for developing the custom designed map to use as the Gather.Town space presented itself in December 2021, which was a few months before the planned quasi-experimental design research was to take place. Due to a new Covid-19 variant outbreak, the annual South African Maths Olympiad Camp that was to take place at a physical location in Cape Town in December 2021, had to be shifted online. A solution had to be found for which videoconferencing platform to switch to. This was also the perfect opportunity to run the supplemental study on the educators/coaches.

Since the camp consisted of 40 students from grade 5 to grade 11, as well as 9 coaches, the organisers agreed to buy a subscription to Gather.Town in order to allow 50 people to use the Gather.Town space simultaneously. Unfortunately this subscription only lasted a month and was no longer valid when the planned quasi-experimental design study took place. The map was therefore simultaneously developed for the needs of the camp as well as for the research to take place later. Since the camp consisted of two groups of students, intermediates and advanced (the usual beginner component fell away due to Covid-19), the map needed at least two classrooms.

A building consisting of three floors as well as a basement was designed on the map. The ground floor featured the entrance to the building as well as a few other doors leading to the outside, where a walkway cut a path through the grass from one of the outside doors to another outside door. The ground floor of the interior of the building consisted of an entrance portal, a restaurant as well as a common area. This common area featured either as an assembly hall or as a movie theatre. To the side there was a staircase to access the other floors. The first floor served as the main education facilities and contained four classrooms. Two of the classrooms were normal classrooms where lectures were given, while the other two classrooms were equipped with books and computers respectively. One classroom had a

computer on each desk, while the other classroom had a book on each desk. The idea behind this was that participants could visit one of these classrooms and sit at a desk and interact with either the book object or the computer object and each of the books or computers would link to either a mathematically relevant website or a set of notes respectively. Each of the two normal classrooms intended for lectures had a whiteboard that served as a collaborative whiteboard that the lecturer as well as the students could interact with.

Figure 1 shows one of the two main classrooms on the first floor used for lectures. There are 12 tables each with 2 chairs where students could sit and hence enough seats for 24 participants. In the front of the room is an interactive white board. For further visual effect a water cooler was added to the front of the classroom.

Figure 1: One of the two main classrooms used for lectures

Figure 2 shows the minimap overlaid on the normal map. The minimap shows the outlines of the first floor of the building. The minimap is useful for navigation. Furthermore, on the right hand side a private area with a big table and chairs around it is visible.

Figure 2: The minimap

Apart from the classrooms where most lectures took place, the custom design option of the space meant that areas for learning other than classrooms could be developed. Hence

the learning experience of students could be enhanced through gamification-related increase of sense of agency (Taub et al., 2020). One area was developed on the ground floor for just such an opportunity. Figure 3 shows the map on the ground floor where the geography of the city of Königsberg (now called Kaliningrad) from 1736 was mimicked in order to teach a branch of mathematics called graph theory. The famous Königsberg's bridges problem was what sparked the invention of graph theory (Weisstein, n.d.). This gamification allowed participants to try to solve a mathematical problem in a space mimicking the physical world. Instead of asking students sitting in a class to abstractly think if given this map they can traverse each of the seven bridges exactly once and end where they started, students could, through the means of walking around with their avatar, try it out for themselves.

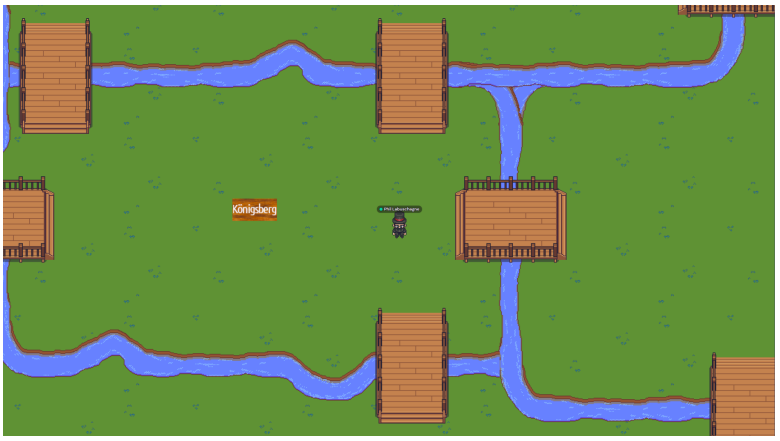

Figure 3: The map of Königsbergs' bridges

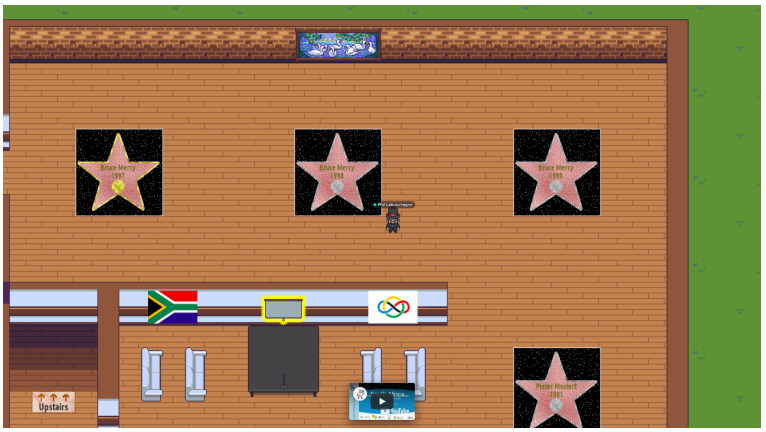

Figure 4: The start of the Walk of Fame

Another way gamification added a sense of agency was the Walk of Fame, which is shown in Figure 4. This is like a Hall of Fame, but it is a walkway of stars commemorating the South African team members who won gold, silver and bronze medals at the International Mathematical Olympiad and was designed to honour them as well as be a motivating factor

to the students attending coaching sessions. The hope was that they might be inspired to work hard enough so that they can also one day earn a place on this Walk of Fame.

Figure 5 shows the games' floor. Each carpet represents a private area where participants could play games with each other. Some of these games were mathematical while other games were purely just for socialising between classes.

Figure 5: Games' floor

As can be seen from Figures 3, 4 and 5, a custom designed map was necessary in order to tailor the learning environment to the learning experience and enhance the learning experience. Additionally, there were also numerous easter eggs and other exciting elements built into the space in order to provoke excitement in the students. Various private spaces were also created so that participants could have conversations in smaller groups, while having a feeling that they have some privacy. All this was designed to try and mimic the physical world as closely as possible.

Results

Main study

Attendance of coaching sessions

The design of the study was such that participants for the study were drafted upon their indication of availability for all 6 the coaching sessions. Participants who indicated that they were not available for all sessions were excluded from the study. This would enable a measurement to be made of the commitment to the coaching sessions. A record of class attendance was kept and the results are listed in Table 1. Although the intention was that participants should attend all 6 coaching sessions, unfortunately loadshedding hit South Africa in the first week of the coaching sessions and a number of the participants did not have electricity at the time of the coaching sessions and hence no internet, which was likely a big reason for the lower than expected numbers.

Table 1. The number of coaching sessions attended by participants

Number of sessions attended (out of 6)	Primary school students	High school students
6	9	14
5	8	10
4	1	9
3	4	5
2	1	3
1	0	0
0	2	7

Questionnaire responses

The questionnaire was completed by 47 participants during the last coaching session and a further 12 completed it after an email request. Those who never attended a single class were not asked to complete the questionnaire, which meant only 64 participants were asked to complete the questionnaire. This gave n=59 for all groups combined and a response rate of

92.2%. For primary school students the responses were *n*=21 and a response rate of 91.3%, while for high school students it was *n*=38 and a response rate of 92.7%.

UEQ Comparison between Zoom and Gather.Town

The User Experience Questionnaire's analysis tool (*User Experience Questionnaire (UEQ)*, n.d.), which gives a comparison of the scale means was run on all but two respondents to the questionnaire. The questionnaire asked to evaluate each of Zoom and Gather.Town on 26 items, which were combined into 6 categories (attractiveness, perspicuity, efficiency, dependability, stimulation, novelty) for evaluation (Schrepp et al., 2017). Since two of the high school participants did not attend both Zoom and Gather.Town coaching sessions, but only two Zoom sessions or two Gather.Town sessions, they might not have been able to compare the platforms fairly and hence they were not considered when running the User Experience Questionnaire analysis tool.

Figure 6 shows the comparison of Zoom versus Gather.Town with *n*=57 over all the participants. A two sample t-test was done which assumed unequal variances and tested whether the scale means of Zoom and Gather.Town differed significantly. The results of the t-test were 0.0000 for attractiveness, 0.0001 for perspicuity, 0.0104 for efficiency, 0.0002 for dependability, 0.0000 for stimulation and 0.0000 for novelty. The t-test showed a significant difference in all six categories at a significance level of 0.05.

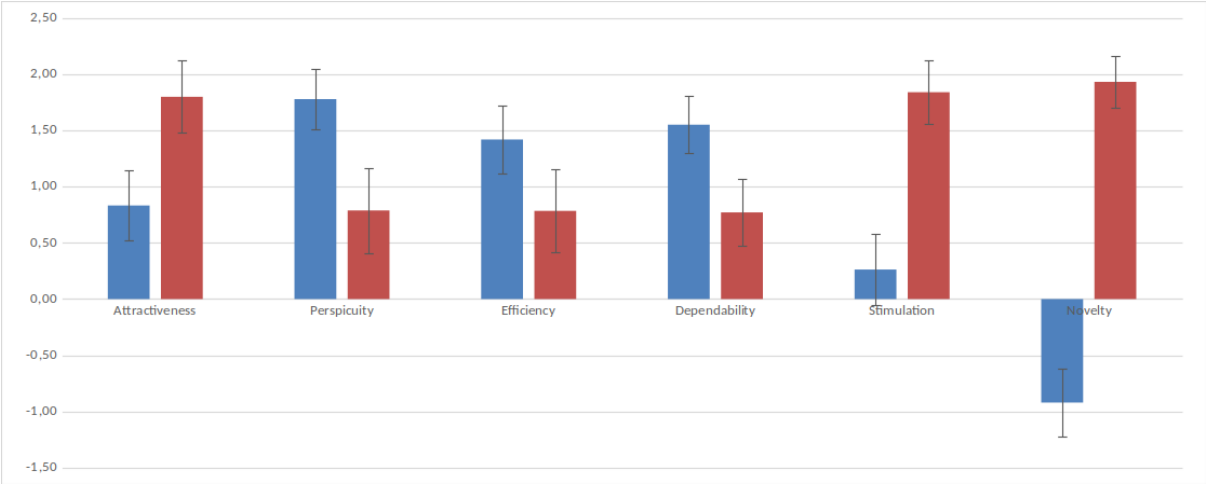

Figure 6: Comparison of the Scale Means from the User Experience Questionnaire's analysis tool for the participants overall with *n*=57. Zoom is indicated in blue and Gather.Town is indicated in red. The vertical axis indicates the average score on the 7-point Likert scale ranging from -3 to 3 (higher score is better) in each of the six categories.

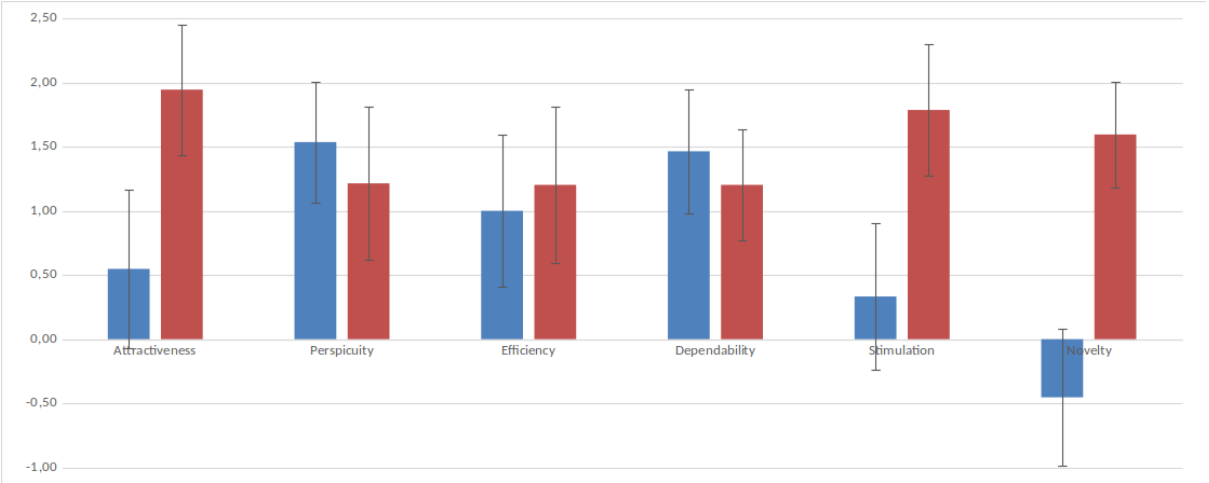

Figure 7: Comparison of the Scale Means from the User Experience Questionnaire's analysis tool for the primary school students with *n*=21. Zoom is indicated in blue and Gather.Town is indicated in red. The vertical axis indicates the average score on the 7-point Likert scale ranging from -3 to 3 (higher score is better) in each of the six categories.

Figure 7 shows the comparison of Zoom versus Gather.Town with *n*=21 for the primary school students. The results of the two sample t-test were 0.0015 for attractiveness, 0.4116 for perspicuity, 0.6435 for efficiency, 0.4315 for dependability, 0.0006 for stimulation and 0.0000 for novelty. The t-test showed a significant difference in three of the categories at a significance level of 0.05. There was a significant difference for attractiveness, stimulation and novelty. There was no significant difference for perspicuity, efficiency and dependability.

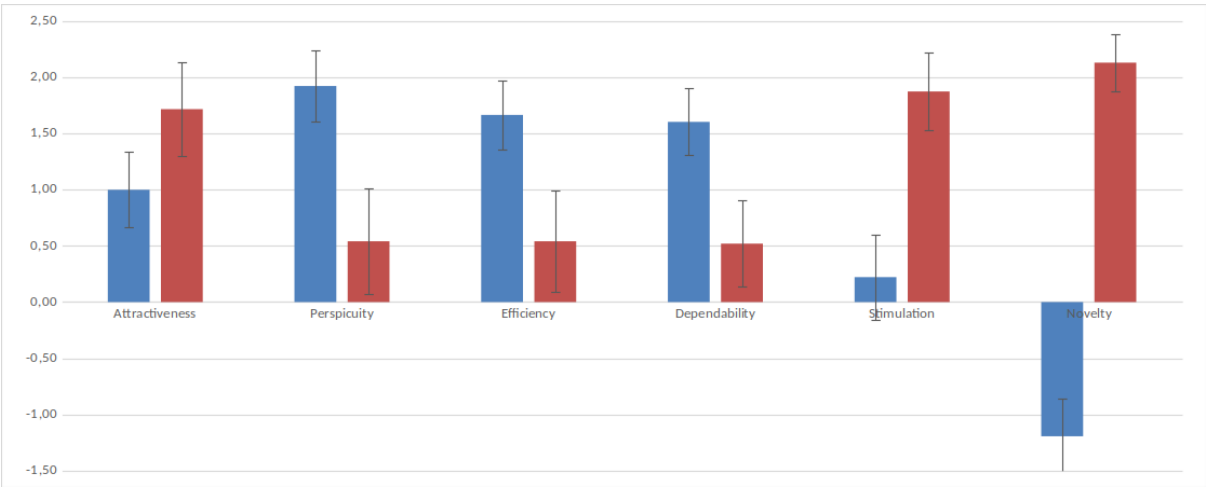

Figure 8: Comparison of the Scale Means from the User Experience Questionnaire's analysis tool for the high school students with *n*=36. Zoom is indicated in blue and Gather.Town is indicated in red. The vertical axis indicates the average score on the 7-point Likert scale ranging from -3 to 3 (higher score is better) in each of the six categories.

Figure 8 shows the comparison of Zoom versus Gather.Town with *n*=36 for the high school students. The results of the two sample t-test were 0.0105 for attractiveness, 0.0000

for perspicuity, 0.0002 for efficiency, 0.0000 for dependability, 0.0000 for stimulation and 0.0000 for novelty. The t-test showed a significant difference in all six categories at a significance level of 0.05.

Table 2 shows the comparison of Zoom versus Gather.Town for the participants overall, the primary school students and the high school students with the means and standard deviations extracted from the analysis tables. The full tables are given in the appendix C.

Table 2. The User Experience Questionnaire's Comparison of Scale Means showing the extracted mean scores (standard deviations given in brackets) from a 7-point Likert scale ranging from -3 to 3 (higher score is better).

	Participants overall		Primary school students		High school students	
	Zoom	Gather Town	Zoom	Gather Town	Zoom	Gather Town
Attractiveness	0.83 (1.21)	1.80 (1.24)	0.55 (1.45)	1.94 (1.19)	1.00 (1.03)	1.72 (1.27)
Perspicuity	1.78 (1.03)	0.79 (1.45)	1.54 (1.10)	1.21 (1.39)	1.92 (0.97)	0.54 (1.54)
Efficiency	1.42 (1.16)	0.79 (1.43)	1.00 (1.38)	1.20 (1.43)	1.67 (0.94)	0.54 (1.39)
Dependability	1.55 (0.99)	0.77 (1.15)	1.46 (1.13)	1.20 (1.01)	1.60 (0.91)	0.52 (1.17)
Stimulation	0.26 (1.21)	1.84 (1.10)	0.33 (1.33)	1.79 (1.20)	0.22 (1.16)	1.88 (1.05)
Novelty	-0.92 (1.16)	1.93 (0.89)	-.045 (1.25)	1.60 (0.97)	-1.19 (1.02)	2.13 (0.79)

Preference of videoconferencing platform in relation to class attendance

In order to deduce the preference of students between Zoom and Gather.Town, the User Experience Questionnaire was used, since that directly compared Zoom to Gather.Town. Although there are six categories of comparison, the category of attractiveness was used to determine the preference of students because "... a user's general impression is captured by the Attractiveness scale …" (Schrepp et al., 2017, p. 41). Table 3 shows the Pearson correlation coefficient that was calculated to measure the correlation between attending coaching sessions and the preference for Zoom and Gather.Town. Two Pearson correlation

coefficients were calculated. One included the two students who did not attend sessions in both Zoom and Gather.Town and the other excluded these two students. It was decided to analyse attendance both when including and excluding them. Although they could not give a fair comparison between Zoom and Gather.Town, their attendance or lack thereof could potentially still provide valid information with respect to their preference for the platforms.

Table 3. Pearson correlation coefficients of platform preference versus sessions attended.

	Preference for Zoom	Preference for Gather.Town
Primary school students with *n*=21	-0.10	0.09
High school students with *n*=38 (*n*=36)	-0.21 (-0.05)	0.47 (0.30)
Participants overall with *n*=59 (*n*=57)	-0.19 (-0.09)	0.38 (0.24)

Results of the pre-test and post-test

Since the results of the pre-test and post-test were only important with respect to comparing how platform preference influenced academic achievement, only participants who wrote both pre-test and post-test as well as completed the questionnaire were considered.

Table 4. Results of the participants in Round 1 and Round 2 of the International Mathematics Assessments for Schools, which served as the pre-test and post-test.

	Primary school students (*n*=20)		High school students (*n*=36)	
	Pre-test	Post-test	Pre-test	Post-test
Test counted out of	100	100	100	100
Mean	34.9	19.9	24	9.58
Standard deviation	12.67	3.07	10.53	7.61
Kurtosis	-1.25	2.65	1.00	1.50
Skewness	0.11	1.56	1.03	1.05
Median	33	18	22	9
Maximum	55	57	54	34
Minimum	13	4	6	0
Range	42	53	48	34

One of the primary school students did not write the post-test. Furthermore, the two high school participants who didn't attend coaching sessions in both Zoom and Gather.Town have been excluded. Hence n=20 for primary school students and n=36 for high school students. Table 4 shows these results.

Comparison between student performance and platform preference

Since a pre-test and post-test were written, a comparison could also be done on how student performance was correlated with student preference between the two platforms of Zoom and Gather.Town. Table 5 shows the Pearson correlation coefficients comparing the improvement from the pre-test to the post-test to their preference of platforms between Zoom and Gather.Town. Furthermore, an extra statistic was also measured in how strong this preference was.

Table 5. The Pearson correlation coefficients for comparison between performance in pre-test and post-test and preference of platform.

	Primary school students	High school students
Preference for Gather.Town compared to improvement in tests	0.35	-0.08
Strength of preference compared to improvement in tests	0.30	-0.04

Supplemental study

Of the 8 educators/coaches at the camp who were asked to complete the questionnaire, 6 completed the questionnaire and the response rate was 75%. The coaches rated Gather.Town as 4/5 stars on average (n=6) in the first section of the questionnaire, which was taken from the survey of McClure and Williams (2021). When answering the question whether they would like to see more coaching sessions delivered with Gather.Town, 83% (n=6) answered that they would in fact like to see more coaching sessions with Gather.Town, while the remaining respondent indicated unsureness rather than unwillingness to coach over Gather.Town in the future.

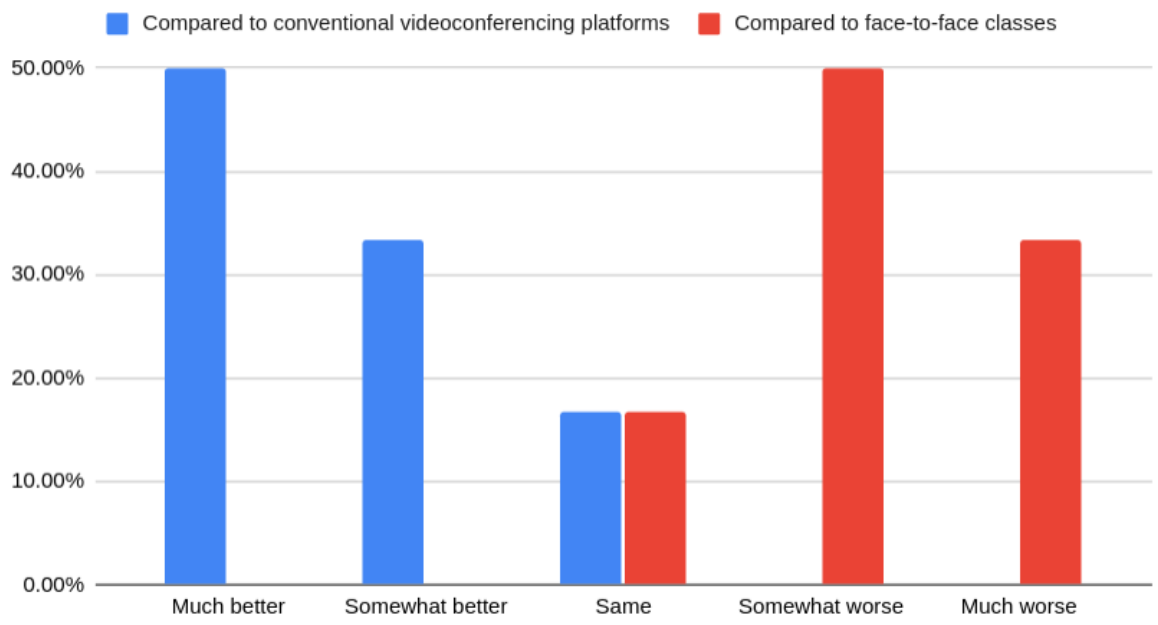

Figure 9: Coaches comparing their experience of Gather.Town to conventional videoconferencing platforms and face-to-face coaching. The vertical axis measures the percentage of respondents.

Figure 9 shows how they rated Gather.Town to conventional videoconferencing platforms (blue) as well as face-to-face coaching (red). Coaches were also asked to justify their choice of comparison between Gather.Town and conventional videoconferencing platforms as well as Gather.Town and face-to-face coaching. The answers provided in this qualitative data question supported the quantitative data collected by the previous question, as shown in Figure 9. Respondent 1 chose 'same' for both questions, while all the other coaches chose a scale of better or worse. Respondent 1 justified it by arguing: "It's difficult to compare GatherTown, other software and face-to-face sessions on a scale of 'which one is better or worse' - they are useful for different things … so comparing those two is really comparing apples to oranges."

However, even though respondent 1 rated Gather.Town as 'same' and argued why they should not be compared, respondent 1 still agreed with most of the other respondents on some benefits of Gather.Town, since responded 1 continued and also commented: "...it gives the students more agency over their virtual presence and lets them choose, for example, which other students to have discussions with…"

This for instance agrees with respondent 2 who commented: "... makes discussions more flexible than something like Zoom breakout rooms…" as well as respondent 6 who commented: "Gathertown excels here and creates a sense of community among students and

lecturers. Having been both a lectuer and student during online learning, I feel that Gathertown manages to minimize the disconnect and distance felt."

However, respondent 6 went even further and stated something that no one else stated and is worth highlighting, which is that Gather.Town unlike conventional videoconferencing platforms doesn't abruptly end when the training session is over. Gather.Town behaves much like school where students can still walk around school and socialise after class:

> It is incredibly hard for students whose only medium is online learning to create or maintain relations with other students/lecturers as after meetings the session is usually terminated. Gathertown remedies this by allowing one to move wherever and talk to whoever one wants to and in doing so better simulates a school environment.

Respondent 5 echoed the other respondents, but also indicated that a preconceived notion of a potential disadvantage of Gather.Town turned out to be false: "... the virtual environment that gathertown provides at least helps the children remain interested, it's more fun and engaging that zoom or msteams. I thought this would lead to children being distracted, but this wasn't the case …"

However, all respondents seem to mostly agree that face-to-face have a lot of advantages over Gather.Town with respondent 4 who summarised it as: "But nothing can beat face to face." Respondent 6 agreed: "I don't believe online environments could or should ever replace face-to-face sessions."

The question which asked coaches to rank 6 items in the order they found them most useful to least useful, had coaches choosing the ability to discuss with peers as the most useful. The second most useful was the ability to access private spaces and the third most useful was the ability to go where you want. The aesthetics of the platform ranked last and the placement of interactive resources second last. The ability to discuss with a coach or educator ranked fourth. Even though the aesthetics of the platform ranked last when coaches ranked the 6 items from most useful to least useful, respondent 3 concluded the first section of the survey, where the last question was an open question asking for final comments, with "A large part of the success of the experiment with Gather Town was the amount of effort put into designing the map/rooms/etc... I can imagine the experience being significantly worse if the virtual world was more generic."

Apart from the survey from McClure and Williams (2021), which the coaches completed as the first section of the questionnaire, they also completed the User Experience Questionnaire (Schrepp et al., 2017) for both Zoom and Gather.Town and Figure 10 shows the comparison of Zoom versus Gather.Town with n=6 for the coaches. A two sample t-test was done which assumed unequal variances and tested whether the scale means of Zoom and

Gather.Town differed significantly. The results of the t-test were 0.0005 for attractiveness, 0.2122 for perspicuity, 0.4412 for efficiency, 0.7365 for dependability, 0.0000 for stimulation and 0.0000 for novelty. The t-test showed a significant difference in three of the categories at a significance level of 0.05. There was a significant difference for attractiveness, stimulation and novelty. There was no significant difference for perspicuity, efficiency and dependability.

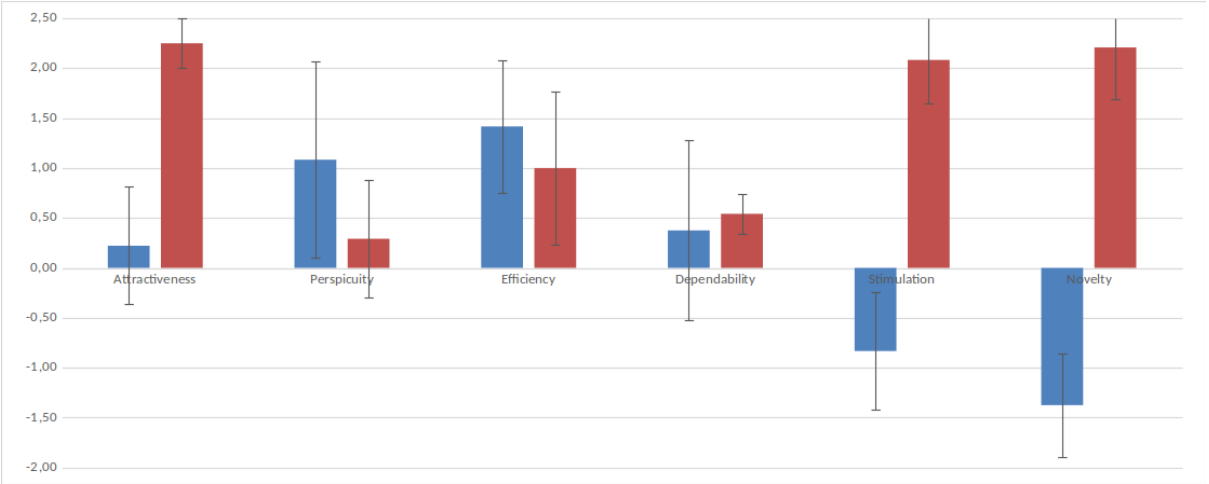

Figure 10: Comparison of the Scale Means from the User Experience Questionnaire's analysis tool for the coaches with *n*=6. Zoom is indicated in blue and Gather.Town is indicated in red. The vertical axis indicates the average score on the 7-point Likert scale ranging from -3 to 3 (higher score is better) in each of the six categories.

Discussion

According to the findings of Latulipe and De Jager (2022) conventional videoconferencing platforms like Zoom have the benefit of "being robust, familiar and easy to use", but they continued "most students found various positive aspects of the Gather.Town experience to outweigh the minor technical difficulties …" (Latulipe & De Jaeger, 2022, p. 416). The results of the current study support the results found in literature with Gather.Town not completely outperforming Zoom and hence conventional videoconferencing platforms in all aspects, but most students and coaches found Gather.Town more attractive than Zoom.

The main study compared Gather.Town to Zoom through oscillating coaching sessions between Gather.Town and Zoom and also measured academic performance in comparison to platform preference. Furthermore, it also measured differences in the age groups of 12 to 13 versus 14 to 16. The supplemental study compared Gather.Town to Zoom from the perspective of Olympiad coaches.

Among all three the groups of high school students, primary school students and coaches Gather.Town ranked significantly better than Zoom on attractiveness, stimulation and novelty than Zoom. Comparing the scale means on these three categories to the benchmark set by the User Experience Questionnaire (Schrepp et al., 2017), it is also possible to get a classification of these aspects in comparison to a wider range of products.

Gather.Town rates as excellent in all three these categories among participants overall as well as primary school students. However, among high school students, stimulation and novelty rate as excellent, but attractiveness only rates as good. In contrast, Zoom rates as bad in all three categories among primary school students. However, among high school students and participants overall, Zoom rates as below average for attractiveness, but rates as bad for stimulation and novelty. Hence Gather.Town at least enhances the learning experience with respect to attractiveness, stimulation and novelty.

Gather.Town did not outperform Zoom on the three categories of perspicuity, efficiency and dependability. However, although Zoom outperformed Gather.Town at a significant level in all three these categories for high school students as well as for the participants overall, Zoom did not outperform Gather.Town at a significant level among primary school students or coaches. The reason for this can either be attributed to there being a difference in perspectives of high school students compared to the primary school students and coaches or because the sample size of the high school students was larger than those of the primary school students and coaches.

Comparing the three categories of perspicuity, efficiency and dependability to the benchmark, Zoom rates as excellent only in the category perspicuity, but only among the high school students. Zoom otherwise rates as above average or good in these three categories, while Gather.Town rates as always above average among primary school students and a combination of below average and bad among high school students and participants overall.

The results from the User Experience Questionnaire, both between Zoom and Gather.Town as well as in comparison to the benchmark are in line with the findings in other studies (Latulipe & De Jaeger, 2022; McClure & Williams, 2021; Najjar et al., 2022; Samiei et al., 2020) which described the overall experience of Gather.Town as positive, especially on attractiveness, stimulation and novelty characteristics, but a bit haunted with glitches and bugs and hence not as dependable.

Although Gather.Town does enhance the learning experience at least in some aspects, there is no substantial evidence to support that it also enhances academic achievement. The Pearson correlation coefficients for comparing performance in the pre-test and post-test to the platform preference is not significant. For high school students the values of -0.08 and -0.04 are intrinsically 0 and although the primary school students had values of 0.35 and 0.30, which starts indicating some correlation, these values are still too low to indicate a correlation between platform preference and improvement in performance at a significant level.

There are two possible reasons for this lack of correlation. The first is that improvement in performance is indeed not platform dependent. The second possible reason is that the pre-test and post-test as well as these extracurricular coaching sessions were done on competition mathematics and they do not follow a set curriculum and competitions also try to test creativity of students and therefore results do not necessarily follow a normal distribution and can sometimes be volatile.

As for the preference of videoconverencing platform in relation to class attendance, the Pearson correlation coefficients were again not high enough to indicate a correlation. A further complication in this case was that a lack of electricity affected class attendance and hence lack of class attendance was not necessarily the choice of participants.

The perspectives of the coaches are mostly similar to the perspectives of the educators in the study done by McClure and Williams (2021) and hence this study strengthens those findings as well. A surprising difference though was in how the coaches and the educators (McClure & Williams, 2021) ranked the importance of the six items of placement of interactive resources, ability to discuss with peers, ability to discuss with lecturer or demonstrator, ability to access private spaces, the aesthetics of the platform and the ability to

go where you want. Only one of the top three ranked items overlapped. Ability to discuss with peers was ranked first by the coaches, but third by the educators (McClure & Williams, 2021). While the educators in the McClure and Williams (2021) study found the ability to discuss with the educator and the placement of interactive resources as the other important features, the coaches focussed rather on the ability to access private spaces and the ability to go where you want as the other important features. A possible explanation for this could be that the Gather.Town space developed for this study did not make use of one of the Gather.Town templates, but rather an extravagant building with lots of private spaces, hidden areas as well as easter eggs that enticed exploration.

In conclusion, to answer the research questions, the mathematical Olympiad coaches did indicate a preference for Gather.Town and its gamification features. Although they mostly would prefer face-to-face coaching sessions, they do believe Gather.Town is better suited for online coaching than conventional videoconferencing platforms. Although there seems to be a slight difference between the preferences of upper primary school students and junior high school students in some aspects of comparison between Gather.Town and Zoom, these could potentially be due to a smaller sample size for the upper primary school students. This study, however, could not produce evidence that a preference for Gather.Town leads to improvement in the extracurricular setting of competition mathematics with respect to results. Regardless, there was generally a preference for Gather.Town and thus Gather.Town can enhance the learning experience among students aged 12 to 16 in an extracurricular setting.

One of the limitations of this research study is that it was based in an extracurricular setting and therefore could not answer the research gap of whether a preference for Gather.Town could enhance the academic performance of students in a formal education setting. It is therefore recommended that future studies investigate whether Gather.Town can also lead to an improvement in academic results in a formal education setting.

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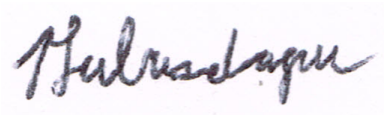
Author’s declaration

I hereby declare that I have written this thesis independently and that all contributions of other authors and supporters have been referenced. The thesis has been written in accordance with the requirements for graduation theses of the Institute of Education of the University of Tartu and is in compliance with good academic practices.

Signature:  Date: 03.06.2022

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Appendix A. Questionnaire for the main study

Zoom vs GatherTown Research Questionnaire

This questionnaire has been designed to test your experience in Zoom and GatherTown and compare them. Part 1 consists of questions concerning Zoom. Part 2 consists of the same questions but concerning GatherTown. I kindly request that you complete the questionnaire so that I can compare the Zoom vs GatherTown experience. Please try and be as honest as you can. Please note that although the form captures names, it is only meant to check who submitted responses and no names will be mentioned in the thesis. Furthermore, the responses are meant to test your experience with the platforms of Zoom and GatherTown and the questions are about the use of the platforms. This form does not inquire as to whether or not you understood the mathematical content. I wish to express my appreciation for you taking the time to participate in my classes and also taking the time to complete this questionnaire.

For the assessment of Zoom and GatherTown, please fill out the following questionnaire. The questionnaire consists of pairs of contrasting attributes that may apply to the product. The circles between the attributes represent gradations between the opposites. You can express your agreement with the attributes by ticking the circle that most closely reflects your impression. Please decide spontaneously. Don’t think too long about your decision to make sure that you convey your original impression. Sometimes you may not be completely sure about your agreement with a particular attribute or you may find that the attribute does not apply completely to the particular product. Nevertheless, please tick a circle in every line. It is your personal opinion that counts. Please remember: there is no wrong or right answer!

Part 1: Zoom

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Part 2: GatherTown

	1	2	3	4	5	6	7		
annoying	○	○	○	○	○	○	○	enjoyable	1
not understandable	○	○	○	○	○	○	○	understandable	2
creative	○	○	○	○	○	○	○	dull	3
easy to learn	○	○	○	○	○	○	○	difficult to learn	4
valuable	○	○	○	○	○	○	○	inferior	5
boring	○	○	○	○	○	○	○	exciting	6
not interesting	○	○	○	○	○	○	○	interesting	7
unpredictable	○	○	○	○	○	○	○	predictable	8
fast	○	○	○	○	○	○	○	slow	9
inventive	○	○	○	○	○	○	○	conventional	10
obstructive	○	○	○	○	○	○	○	supportive	11
good	○	○	○	○	○	○	○	bad	12
complicated	○	○	○	○	○	○	○	easy	13
unlikable	○	○	○	○	○	○	○	pleasing	14
usual	○	○	○	○	○	○	○	leading edge	15
unpleasant	○	○	○	○	○	○	○	pleasant	16
secure	○	○	○	○	○	○	○	not secure	17
motivating	○	○	○	○	○	○	○	demotivating	18
meets expectations	○	○	○	○	○	○	○	does not meet expectations	19
inefficient	○	○	○	○	○	○	○	efficient	20
clear	○	○	○	○	○	○	○	confusing	21
impractical	○	○	○	○	○	○	○	practical	22
organized	○	○	○	○	○	○	○	cluttered	23
attractive	○	○	○	○	○	○	○	unattractive	24
friendly	○	○	○	○	○	○	○	unfriendly	25
conservative	○	○	○	○	○	○	○	innovative	26

Appendix B. Questionnaire for the supplemental study

GatherTown Research Questionnaire

Your participation in this questionnaire is completely voluntary and you may opt not to submit your responses at any time prior to clicking the ‘submit’ button following your completion of the final question. Should you wish to do so, simply close this window. By completing this survey, you are consenting to participate in this study and for the data to be used in research for a masters thesis. Any personal information that you do submit will not be made public and the emails and names collected are only used to determine who submitted the questionnaire. Responses will be encoded as Lecturer 1, Lecturer 2 etc where necessary in the thesis. Although for the most part, the data will be analyzed in group format and not as individual responses.

Part 1 specifically addresses educational questions. Parts 2 and 3 compares the same characteristics between Zoom and GatherTown. Part 2 is Zoom and Part 3 are the same questions but for GatherTown. Please try and remember your experience of the GatherTown environment during the December Camp and try and be as honest with your responses as you can when answering.

I wish to express my appreciation for you taking the time to complete this questionnaire. The results will hopefully aid in improving my thesis.

Part 1: Educator Experience

1. How would rate GatherTown as an educational platform from your experience 1 star, 2 stars, 3 stars, 4 stars or 5 stars?

2. How would you rate GatherTown as an educational platform in comparison to

	Much better	Somewhat better	Same	Somewhat worse	Much worse
...other distance learning software (e.g. MS Teams Meetings)	○	○	○	○	○
...face-to-face sessions	○	○	○	○	○

3. Please comment on reasons for your selections in the above.

4. Please rank the following elements of the GatherTown session in the order you found them most useful to least useful

	Most useful	Second most useful	Third most useful	Fourth most useful	Fifth most useful	Least useful
Placement of interactive resources	○	○	○	○	○	○
Ability to discuss with peers	○	○	○	○	○	○
Ability to discuss with lecturer	○	○	○	○	○	○
Ability to access private spaces	○	○	○	○	○	○
The aesthetics of the platform	○	○	○	○	○	○
Ability to go where you want	○	○	○	○	○	○

5. State how you agree with the statement that GatherTown is a more effective platform

to deliver the following educational practices over standard video-conferencing software

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
Delivering Lectures	○	○	○	○	○	○
Delivering Practicals	○	○	○	○	○	○
Marking Assignments	○	○	○	○	○	○
Communicating with Students	○	○	○	○	○	○
Communicating with Education Team	○	○	○	○	○	○

6. Do you think more educational sessions should be delivered via GatherTown? [Yes, No, Not sure]

7. If you have any final comments on GatherTown as an educational system, please write them below:

Part 2 and part 3 were respectively part 1 and part 2 listed in appendix A.

Appendix C. Comparison of Scale Means tables from User Experience Questionnaire

Participants overall

	Zoom						Gather.Town					
Scale	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval	
Attractiveness	0,83	1,21	57	0,31	0,52	1,15	1,80	1,24	57	0,32	1,48	2,12
Perspicuity	1,78	1,03	57	0,27	1,51	2,05	0,79	1,45	57	0,38	0,41	1,17
Efficiency	1,42	1,16	57	0,30	1,12	1,72	0,79	1,43	57	0,37	0,41	1,16
Dependability	1,55	0,99	57	0,26	1,30	1,81	0,77	1,15	57	0,30	0,47	1,07
Stimulation	0,26	1,21	57	0,31	-0,05	0,58	1,84	1,10	57	0,29	1,56	2,13
Novelty	-0,92	1,16	57	0,30	-1,22	-0,62	1,93	0,89	57	0,23	1,70	2,16

Primary school students

	Zoom						Gather.Town					
Scale	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval	
Attractiveness	0,55	1,45	21	0,62	-0,07	1,17	1,94	1,19	21	0,51	1,44	2,45
Perspicuity	1,54	1,10	21	0,47	1,07	2,01	1,21	1,39	21	0,60	0,62	1,81
Efficiency	1,00	1,38	21	0,59	0,41	1,59	1,20	1,43	21	0,61	0,59	1,81
Dependability	1,46	1,13	21	0,48	0,98	1,95	1,20	1,01	21	0,43	0,77	1,63
Stimulation	0,33	1,33	21	0,57	-0,24	0,90	1,79	1,20	21	0,51	1,27	2,30
Novelty	-0,45	1,25	21	0,54	-0,99	0,08	1,60	0,97	21	0,41	1,18	2,01

High School students

	Zoom						Gather.Town					
Scale	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval	
Attractiveness	1,00	1,03	36	0,34	0,66	1,34	1,72	1,27	36	0,42	1,30	2,13
Perspicuity	1,92	0,97	36	0,32	1,61	2,24	0,54	1,45	36	0,47	0,07	1,02
Efficiency	1,67	0,94	36	0,31	1,36	1,97	0,54	1,39	36	0,45	0,09	1,00
Dependability	1,60	0,91	36	0,30	1,31	1,90	0,52	1,17	36	0,38	0,14	0,90
Stimulation	0,22	1,16	36	0,38	-0,16	0,60	1,88	1,05	36	0,34	1,53	2,22
Novelty	-1,19	1,02	36	0,33	-1,53	-0,86	2,13	0,79	36	0,26	1,87	2,39

Coaches

	Zoom						Gather.Town					
Scale	Mean	STD	N	Confidence	Confidence Interval		Mean	STD	N	Confidence	Confidence Interval	
Attractiveness	0,22	0,74	6	0,59	-0,37	0,81	2,25	0,31	6	0,25	2,00	2,50
Perspicuity	1,08	1,23	6	0,99	0,10	2,07	0,29	0,73	6	0,59	-0,29	0,88
Efficiency	1,42	0,83	6	0,67	0,75	2,08	1,00	0,96	6	0,77	0,23	1,77
Dependability	0,38	1,13	6	0,90	-0,53	1,28	0,54	0,25	6	0,20	0,34	0,74
Stimulation	-0,83	0,74	6	0,59	-1,42	-0,24	2,08	0,54	6	0,43	1,65	2,52
Novelty	-1,38	0,65	6	0,52	-1,89	-0,86	2,21	0,64	6	0,51	1,70	2,72

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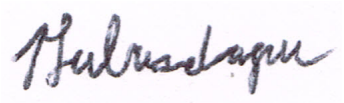

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