Exploring students’ use of online sources in small groups with an augmented reality-based activity — group dynamics negatively affect identification of authentic online information

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Abstract

In this study initially, we wanted to explore students’ use of online sources and how they use online information to try to persuade each other when they get the group assignment to identify misleading from correct information. We grounded our concept on “OnLife” (Floridi, 2015) in which students used online information to find arguments for their actions. We created an AR-based campus tour for mobile devices in which students discussed content, identified correctness of online information and were asked to made a group decision. Four groups have been studied. Video-recorded observation and interviews were applied. During data analysis we found results that point to four distinctive patterns of relationships between social in-group dynamics and the identification of authentic online information: a) network of equal members, b) omission of one person, c)
one person guides the others, d) no collaborative reasoning. The result is a ‘Happy Surprise’, it shows that social dynamics affected group performance stronger than equal access to online sources. Equal access to online information did not lead to a reasonable based-on-facts discussion. Group dynamics diminished the advantage of equal access and impacted decision-making more than the information itself. Because of the small study size, generalization of results is limited, but lays a foundation for follow-up or experimental studies.

Keywords: Psychology, Information science

1. Introduction

When people access online sources, they face several challenges. First, it is difficult for people to authenticate online information (Stanford Study, 2016), and second, personalized digital systems accelerate this problem. Such systems contribute to an Echo chamber and may support the distribution of misleading, false or correct information based on users click behavior and preferences. The more often a statement is distributed online, although false, the more the likelihood that people believe it. This is called Illusionary Truth Effect, and even if a person knows the facts, and has the knowledge, this psychological effect does not protect against it (Fazio et al., 2015).

Personalized systems and Augmented Reality (AR) applications are embedded into sociotechnical environments and becoming increasingly linked with things and content personalized to the person interacting with a digital information system. As Erdelez and Jahnke (2018) argued, this “is not limited to the material word of engineering firms anymore.” (p. 1). Users are used to reading customized ads as presented in their Facebook and Twitter feeds. Personalized or augmented information (e.g., the Historic River Walk tour in Chicago) are displayed on users’ mobile devices. As the digital personalized systems and Augmented Reality (AR) becomes more integrated in everyday life (Floridi, 2015), digital billboards and other Internet connected devices will be able to identify nearby individuals based on information stored in their smartphones and other mobile devices. Such data are presented as augmented or information specifically created for that person. It makes it difficult for people to identify and authenticate that personalized information.

According to the Pew Research Center that surveyed 1,000 U.S. adults in December 2016, 64% of U.S. adults reported that fake or fabricated stories cause a great deal of confusion about basic facts pertaining to current issues and events. Furthermore, 23% admitted that they have shared a fake story either knowingly or unknowingly. Almost 40% say they are very confident that they can spot or determine fake news with 45% feeling somewhat confident. Likewise, the Stanford Study (2016) reported similar findings focused on middle school, high school and college level students.
For the social media test, students read a tweet and explained why it might or might not be a useful source of information. Online tasks included article evaluation for website trust, researching a claim online, website reliability (partisan site), and a social media video. The Stanford study found students could easily multi-task but when it came to evaluating information from social media they were easily “duped” (p. 4). Eighty percent of the school students and 60% of college students were not at the mastery level meaning that they did not correctly evaluate the information. Students in all three age groups overwhelmingly could not identify false information (middle school, high school, college).

While the Stanford study focused on individual reasoning, this prompted our interest to pursue research in small groups. We theorized, when the individual person struggles with evaluating online information and identifying misleading or false from correct information, perhaps a small group would do perform better. However, before we actually can design an experimental study, we were also aware of the fact that we needed more knowledge about small groups, specifically how they deal with the authentication of online sources in practice. We expected outcomes that point to group discussions that are reasonable and based on facts because of equal access to online information. We also thought that there will be some kind of different group discussion patterns (Jahnke, 2010) that might point to how groups handling the authentication of online sources differently. The results of the study though revealed some surprisingly new findings.

We report this exploration study here. Our goal was to explore the relationships between social in-group dynamics and the identification of authentic online information. We designed a gamified AR, augmented online information, activity for mobile devices outdoors that simulated daily group conversations in small groups using web-enabled phones.

2. Background

Specific forms of mobile applications, for example game-based learning and Augmented Reality technologies have the potential to bring learners to deeper levels of cognition as they gain new and additional perspectives through context awareness (Cheng and Tsai, 2013; Dunleavy et al., 2009). While it seems, this is an advantage for learners, it is still unclear, if and how users questioning the augmented information, i.e. if they expect to be exposed to false or misleading data visualization, if and how they identify augmented online information as presented in AR environments.

In this section, we present existing literature of AR related work, potential and challenges. This knowledge is useful to understand the AR activity design that we developed for this study focused on small groups. We want to point to design constraints that come along with an AR activity for small screens.
Research on small groups using digital technologies such as AR. AR research for collaborative learning in general builds on research of small groups that has been studied in a variety of disciplines for many years (e.g., Stanton et al., 2002; Lingnau et al., 2003; Echeverria et al., 2012; Kiyokawa et al., 2002). As Matcha and Rambli (2013) emphasized in their AR study of collaborative interactions, using different technology generates different collaboration environments. This is also true for AR applications in which the augmented information becomes a boundary object between the physical-real materialized world and the digital online world (Lee, 2007). Physical material becomes an important role in studying online group behavior (Cerratto Pargman et al., 2017; Lipponen, 2002). Physical objects are a kind of mediator for group work in many different ways due to their semantic representations, spatial relationships, appearances, and so forth. Depending on their design, they help or hinder to focus attention of group members (Matcha and Rambli, 2013).

Screen Size Matters. When studying AR applications and how small groups use it, researchers should be aware that screen sizes matter. AR in “cave” system, for example, put the users in an immersive augmented reality experience, where projectors are directed to three walls. Small versus large screen research demonstrates the impacts of the screen on group work. Price and Rogers (2004) studied collaboration with young children and found while one student is active on the screen, the other group members were just looking on the actions of the active student. Only one person can control and interact with the system (Scott et al., 2003). Even if there are different computers, Chastine et al. (2007) pointed to major problems in collaboration: one problem is that group members apply different perspectives of viewing which led to the problem that it is unclear to what object the different members refer to. Because this happens online, Group members can no longer rely on general non-verbal communication cues (e.g., eye gaze or gestures).

AR for educational purposes. Museums have embraced the use of AR for educational purposes delivered through mobile devices (Radsky, 2015). Studies highlight that such mobile apps serve well for student inquiry and collaborative learning (Steele et al., 2012). Cook (2010) reported that AR inspired mobile applications support collaborative problem solving. Researchers found positive benefits including increased understanding of content, learning spatial structure and function, long-term memory retention, increased student motivation, student engagement and improved collaboration (Radu, 2014; Bacca et al., 2014). Several studies point to an increase in student motivation, cooperative learning, and increased learning performance with AR (Billinghurst and Duenser, 2012; Antonioli et al., 2014; Patzer et al., 2014). Students express higher level of engagement (Melero et al., 2015).
3. Methods

While previous studies of identifying authentic online information took place indoors, in front of a desktop PC, and focused on individual reasoning (Stanford Study, 2016), we created an AR related environment for small groups as an outdoor activity. We utilized an augmented reality location-based platform and created a gamified outdoor activity as a group task with mobile devices. We specifically targeted participants on the level of graduate students and post-doctoral fellows as opposed to the Stanford Study which focused on middle/high school students and undergraduates. Our research questions were:

- **RQ1.** In a collaborative activity with mobile devices, to identify correct from false answers, what kind of online information do students use to provide evidence for authentic/correct information?
- **RQ2.** In what ways do students influence or try to persuade each other during group discussion? Are there group behavior patterns that affect group performance, which ones?

3.1. Design of three levels of difficulties

While some online information might be easy to verify, other information may be difficult to authenticate. We adopted three levels of difficulties inspired by the Stanford study (2016). The easiest level was fact checking based on numbers (e.g., What year did the Chinese government gift the lions to the School of Journalism — 1931, correct or incorrect?). The medium level was to identify a website’s reliability, in which students determine whether a site or a video is trustworthy (e.g., audio information of the chancellor’s residence). The most difficult level was to authenticate a claim, for example, a story to which information is not easy to find online (e.g., the university’s lions tradition, “Rub the Nose”). We incorporated these three levels into the gamified collaborative activity.

3.2. Design of the gamified activity

Our gamified activity was designed as a mystery quest of the historical quad using the university mascot as the tour guide, see Fig. 1. We chose GuidiGo which is a location based interactive augmented reality game platform. We conducted a usability test (Lewis, 2014) with the result of a usability score of 72.9. The score indicated
there were no technical difficulties with the mobile app in general; easy to use for new users.

The gamified activity was set up as a tour. Participants went to five locations called tour stops following the GPS augmented map with eight tasks in total, see Fig. 1. Once at a location, the app gave the players information that could include, text, images, audio and video. Once viewed there was a question or task that the players performed. The eight tasks were aligned with three levels of difficulties:

- **Task 1**, easy level: Fact, year of delivery of Stone Lions
- **Task 2**, difficult level: Claim, student tradition of David R. Francis nose rubbing
- **Task 3**, difficult level: Claim, ghost in chancellor’s residence story
- **Task 4**, free level to support flow and fun: AR frightful group emoji photo task
- **Task 5**, medium level: Fact check a name not easy to verify, land grant university Morrill Act
- **Task 6**, difficult level: Claim, Jesse Hall windows view
- **Task 7**, medium level: Check website/video, not easy to verify, botanical garden acres
- **Task 8**, free level to support flow and fun: AR Truman the Tiger Mascot Group Selfie

In each task, participants searched for online information that supported the correct answer. Because group dynamics (Strijbos and De Laat, 2010; Jahnke, 2010) may have an impact on the group performance (e.g., trust, whom to believe), we designed the activity in such a way that each group received direct feedback after each task. The feedback was given through winning points, which showed participants whether the group decision was correct or wrong including further information of correct or wrong answer. Group performance in this study was measured by total number of points and amount of total time to finish the collaborative activity.
3.3. Selection of participants

The study was ethically approved by the Institutional Review Board of the University of Missouri and informed consent was obtained from all participants involved in the study. Participants were recruited through an open invitation email invite through the student distribution lists for graduate students and through the research lab. The snowball method (one person recommended another) was used as well as additional recruitment from the research lab students. Information about the participants are listed in the Findings in Section 4.

3.4. Gamified activity day

The gamified activity day was divided into three phases in a total of two hours’ time. Phase 1 was the introduction (15 minutes) in which groups read the consent form. Then, one of our research Group members described the rules and technical aspects of the app, and technology devices were given to the participants (iPad, android tablets, and smartphones). In Phase 2, the group played the gamified activity, which took around 45 minutes or less. GuidiGo operated offline but in order to access online sources, smart phones were used that had unlimited data in case there were weak Wi-Fi spots. In Phase 3, after groups finished the activity, the groups arrived back at the research lab, and we conducted follow-up audio interviews usually lasting about 30 minutes.

3.5. Data collection

We applied qualitative methods such as video-recorded shadow observations (Cohen et al., 2011) and focus group interviews (Harrell and Bradley., 2009). The study was conducted at a Midwestern university in North America, started in January 2017 and ended in May 2017. During the gamified tour, each group had two shadow observers, one video-recorded with the GoPro camera and the second observer was hands-free to take notes. The observers did not help the groups unless there was a technical difficulty. The groups’ discussions, search strategies and their decision data were stored on a server for analysis. Group completion time for the gamified activity started as the group left the research lab and finished when the last task was completed. The group activities ranged from 25 minutes to 62 minutes with the average being 46 minutes. The total time of all four group video recordings was 183 minutes. The follow-up interviews were designed as focus groups with an interview protocol. The post-gamified activity interviews with the students asked about their experience. Questions were divided into three sections. Section 1 was a warm up question asking about the overall gamified activity experience (e.g., Please tell us about your game tour experience. How was it?). Section 2 focused on the main research questions related to online sources used, how they were determined as credible and were they used to influence group decisions. (e.g., What kind of online sources were used during the...
game? During the tour, were you concerned that the information sources were credible or did you not care?) Section 3 questions focused on group roles and function. (e.g., How would you describe the roles in the group? Are you satisfied with group performance, tell us more, why? Did disagreement occur or not during any of the challenges? If so, what did you do about it, how did you handle it?)

The group interviews were audio recorded; a total of 92 minutes, with the average interview taking 23 minutes. In addition, a demographic survey and the 10 items standardized reliable and validated survey for determining the System Usability Scale (SUS) (Sauro, 2015) was applied to test for technology issues and general acceptance rate. Each student filled out the survey individually before the group interview began.

3.6. Data analysis

The data analysis consisted of multiple steps. We applied thematic analysis (Braun and Clarke, 2008). Furthermore, the usability and demographics data were compiled and scored. An ID log with demographic information was created for field notes. After each group activity, the focus group interview notes were compiled. The URL form, filled during the tour by the Groups, was revised into a grid document to track and capture online sources. The analysis sheet contained group observations for each tour stop, group start and stop time and overall score. Each stop included general observations, search strategies, group decisions and story. After all groups completed the activity and group interviews, we listened to each audio and watched each video and transcribed additional information such as observed behaviors and additional quotes that pertained to the research questions. As the data were analyzed, additional notes and questions were logged for findings and conclusions. Two researchers worked together to cross-check the data and themes with a communicative validity approach (Sandberg, 2005).

4. Results

In total, we had 12 participants in four groups of three. Eight were current students, four were not but had master’s degrees and were currently working at the university in IT and educational positions. Recruitment criteria included the requirement that participants speak English. Seven male and five females participated. Six were Masters and six were PhD students. Four were from other countries outside the U.S. and spoke English as a second language. All participants said they use mobile devices every day. Three labelled themselves as beginner, seven as intermediate and two as advanced users.

We labelled the participants as ID1-1 to ID4-3 in which the first number represents the Group 1 (ID1) and the second number the participants in each Group 1 to 3, e.g., ID4-3 means ‘Group 4, Participant 3’.
4.1. Group 1 “Business as usual”

Group 1 consisted of co-workers from the campus IT department. There were two males and one female with 2 Master’s and 1 current PhD student. All had strong computer skills. They ranked themselves as beginners to intermediate for mobile phone gaming applications. All were U.S. citizens with English as their native language. Age range was 44–46. They finished the gamified tour in 51 minutes with a total score of 3700 and ranked 3rd.

The Group performed well together and were very polite and considerate of each other, like they would be in the workplace environment. They handled the gamified activity like a work task. For example, at Task No. 3, the group listened together to the video by forming a circle and leaning in close to hear the audio. They found a good quality website by discussing as a cohesive group, which led them to the correct answer. Task 5 was difficult and it revealed the group implicitly taking on business roles: The group searched several sources online but unsuccessfully. At this point, ID1-3 took lead and coordinated the group by reading questions out loud, while ID1-2 documented the websites’ URL’s. ID1-3 was the ‘searcher’ and found the answer for the group. They looked at a second source of information to ensure the correctness. The group relied on the online resource that was selected for the correct answer.

Each participant performed a specific role but solved the problem together and asked each other for input. They made a group decision by reaching consensus for each task. There was no pressure if they got the answer incorrect. They stayed positive towards each other throughout the entire tour.

4.2. Group 2 “Where is the Proof?”

This Group was all male doctoral students. Two were from other countries and English was not their native language. They all had strong computer skills and intermediate to advanced mobile phone gaming skills. Age range was 31–46. They finished the tour in 62 minutes. This Group took the longest time to finish and they placed last (4th) in overall rankings with a total score of 2800. This Group used voice command to search.

This Group wanted proof from websites for the correct answer before they continued with the next task. That caused a problem at Task 6: one student, ID2-1 knew the answer right away and communicated it to the group. The other two students, however, were suspicious and would not listen to his reasoning. They spent almost 15 minutes trying to come up with an alternative answer and tried to find evidence for the alternative answer. Finally, they made a decision to vote for the answer; they voted against the correct answer and the group lost game points. The following is an excerpt from this conversation:

ID2-1 “I know this (the answer) on base knowledge (…) being a longtime resident and student (…) The answer is ‘Nothing Much.’”
ID2-2 But “a window is something you can see through. You don’t call it a window; would you call it a wall?”

ID2-1 tried to convince his Group members, “Let’s say for example you are in a bathroom and there is a window but it is frosted for privacy so people can’t see in.” (We will not quote the exact words).

But ID2-3 insisted and replied, “We should climb the stairs at Hill Hall to see proof or walk all the way around Jesse Hall for a 360-degree observation.” Also, ID2-3 commented and argued that a window is something you can see through. The discussion about the meaning of window lasted 8 minutes.

ID2-2, “…the dome windows are a window.”

Finally, two members (ID2-2 and ID2-3) voted against the other (ID-2-1) who had the correct information.

During the group interview, the three students commented about their experience. ID2-2 noted, “When you and I went one way and ID2-1 went the other way, I was a little surprised, why, how? A window you must see thru. We were surprised that the answer he provided was correct.” ID2-3 added, “The question from my perspective is what we can see now from the inside of the dome. … what can we see if a person stands inside? According to my understanding it doesn’t matter if the glass is frosted or not frosted because this is a building and it has windows so I can see things from the windows.” While the person (ID2-1) with the correct answer was still surprised, he said, “I (really) tried to support my answer and I knew it was right. To me there was no doubt. The link I was waiting to come up never came up. I respected the fact that I needed to prove it.”

Group members, even when faced with a substantial reason, were not really open to researching or trying new search strategies that would have given them the correct answer. Two students made assumptions about what they thought the logical answer would be, thus clouding their ability to open themselves to other possibilities.

4.3. Group 3 “Not Fast Enough”

This Group consisted of two PhD students and one post-doctoral student; two females and one male. Two were from other countries, English was not their native language. They had strong computer skills and intermediate to advanced mobile phone gaming skills. Age range was 35–54. Having fun and winning was their Group slogan. Group 3 was the fastest Group to complete the tour (25 minutes) but with a total score of 3900 ranked only 2nd.

This Group can be described as very competitive. They were the only Group to run to the first stop and they kept the pace going throughout the entire activity. In fact, they went so fast, one member accidently swiped the screen that caused the group to miss a task that ended up costing them the overall win. They had excellent search...
strategy skills, using voice commands for online searching, and found correct answers faster than any other Group but did not utilize all the AR tour information which would helped to gain more points.

This group’s search strategy was different than the other groups. They started searching for information as they were walking and the self-made tour navigator (ID3-2) coached them with information. At Task 2, for example, ID3-2 read the questions as they went to the location site and kept feeding the group with information during the search, such as what the multiple-choice answers were, to narrow down possibilities as other participants searched. Here is a typical situation from Group 3: ID3-2 coordinated the group, “It is 3 words with letters given for fill-in the blank. Land Grants were issued at this time.” It took them around 4 minutes to complete this task while the other groups took around 10 minutes.

In the interview, the Group discussed their search strategy. ID3-1 found the answer quickly using key words with voice-controlled commands from information that ID3-2 gave. ID3-1 said, “I typed the whole question for the public universities. I scanned the key words in the screen. A very quick scan and decided which to choose that can lead to the answer to the question.” ID3-2 explained the group’s strategy, “They scanned (...) and looked to find answers until they found something they thought would give them the answer.” ID3-1 chose key words and looked “which one can lead to the answer to my question, then I got the answer. (...) I searched very specific key words”. ID3-3 used “Wikipedia could be a valuable source for finding answers. I could find questions relating to history. There are sections in Wikipedia I could skip the entire page and go to a certain section. Eliminate what we won’t need.” And s/he added, “I used key words or repeated question to google. Botanical gardens + acres. Focus on the numbers. I only used Google to search as a search engine. I used the voice function.”

4.4. Group 4 “The Me in the Group”

This Group consisted of two females and one male. Computer and mobile gaming skills were ranked from beginning to intermediate. They were all U.S. citizens and English were their native language. Age range was 37–53. This Group consisted of one Masters student in library science and two professional youth education specialists on campus who were currently not in an academic program. They all had master’s degrees. They finished the tour in 45 minutes which was the second fastest Group but with the highest score of 4300 and ranked 1st. It was the winning Group.

This Group generally worked as individuals within a group. As the activity continued, they looked like they each were playing the game separately. They did not communicate verbally about the questions they were searching. They each did their own search by typing in key words and then made a group decision with whoever found the answer first. The physical proximity to other group members
when searching for online resources was spread far apart compared to the other groups. One member answered a question without getting a final agreement from the other Group members and the answer was incorrect. It was the only question they missed. They were thorough with each task. Time was not a consideration in this Group, but the correct answer was.

A typical situation represents Task 6: they went straight to the question and did not walk to the place. They stayed in the same spot. When they started searching, they stood side by side but did not really discuss or talk to each other during the search. They discussed the question and group agreed that the answer could be both A and B showing views from the quad. However, one member walked away and answered the question before the group made a final decision while searching and the correct answer was eventually found. Here is a typical dialogue: ID4-3 told group s/he knew the answer was both A and B and just needed an online source to confirm it. However, the answer s/he assumed was incorrect. ID4-2 and ID4-1 were still searching to find online information and said that they agreed with ID4-3 initial assumption. ID4-3 then walked away from group and answered question without affirmation while ID4-2 and ID4-3 were still searching. At the same time, ID4-1 found the correct answer but the wrong answer had already been entered. ID4-2 added later, “It was a Group effort but the seeking of the answer was an individual process.”

5. Discussion

RQ1 shed light on online sources that students used to provide evidence for correct or false information. In general, none of the groups missed level 1 questions (easy facts). Almost all groups got level 2 questions correct as well (online source reliability). The second level was to identify a website’s reliability, in which students determined whether a site or a video was trustworthy. The level 3 questions (check a story) are what caused the groups to give the most wrong answers. Checking online sources when it was related to a “claim or tradition” brought up issues of a) what is counted as a credible source, b) what key words to use, and c) participants did not read the entire text of the content that caused them to miss relevant information.

Credible source: All groups used the Google search engine as the main search platform. Participants responded that Wikipedia, .edu or .gov and local news sources were useful. Groups reported that they did not really consider if the site was credible or not because it was not research or political. Here is a dialogue from Group 2: ID2-2, “(...) normally I think of the credibility of the source. If it is .edu you can trust it.” ID2-2 continued asking Group members, “Do you trust everything that’s in Wikipedia?” ID2-3, “I’m not sure, but I think that Wikipedia would be more accurate than a discussion board or forum.” ID2-1, “I really didn’t think about it because these are not polarizing topics. There is no motivation to not have accurate information there.
What is the benefit for someone to put in inaccurate information about these particular topics? There is no positive result to go to that effort. Political topics is a different matter.”

The groups, especially Group 3, had difficulties to trust reliable sources and trusted their own instincts or beliefs rather than the online source. Here is a dialogue from Group 3: ID3-1, “Credible or reliability was not a concern since it was a game but in research it is… It was not harming anyone as long as the answer was given. If I did research it is totally different story.” ID3-3 argued, “Wikipedia we can trust because many people are reading and revising information. If the site looked professional like .edu. A personal web page I cannot trust well. “Edu, Wikipedia looks credible to me.” ID3-2 added, “Validation came if the site had the right answer. I don’t know if the site is right but the answer is wrong so we got to kept looking. Even if it was a non-credible site and they had answers to choose from you were fairly confident if it had the answers.”

**What keywords to use:** Not only the choice of search commands, but also word meanings defined by participants effected their search strategies. When participants searched for answers, the assumptions they placed on the questions or statements either opened up their search possibilities or tainted it with the key words that they used for search purposes. Personal biases played a role in how the questions were searched and this led right from the start to the correct or wrong path. Participants did not search with ‘neutrality’, they also did not question their bias or assumptions which could lead to a more open-minded search strategy. Task 6 with the ‘window’ question is a representative example in which Group 2 experienced difficulties.

**Voice commands vs. keyboard use:** Two groups used voice command vs. two groups that keyed in words, phrases or questions to find web sources. The two groups that used voice command were younger than the two groups that physically keyed in the key words. This suggests that age could impact how participants choose to search and what command words to use. The two groups that did not use voice command stated in the interview that they did not even consider doing that. “It didn’t come to mind” said ID4-2 in the interview.

**Did not read the given information:** We added relevant information in the Guidigo app that gave clues to the quizzes and tasks. None of the groups paid attention to it. Even though it was easily accessible, groups did not really take the time to look at the given information; they read the abstracts only. One explanation may be the time factor of the designed gamified tour; another factor can be that people in the Twitter age are used to reading short sentences and avoid longer ones (e.g., Lee, 2018). Reading the credits text would have helped them to solve the activity in shorter time than they actually performed because it contained hints for the right answers.
RQ2 focused on participants’ strategies, how they influenced or tried to persuade each other during group decision-making. We explored four distinctive behavior patterns that affected the group performance. In the tour stops with the easy level, the groups went with whatever answer was found by a Group member after finding a useful web source. They were democratic and came to a group consensus. In difficulty level questions, however, there were instances where groups assumed an answer and guessed, or Group members did not believe other members and voted against the proposed answer. Fig. 2 visualizes the different forms of group cooperation.

Group 1 split the gamified activity into a work task with professional roles, a leader, a person who documented the online source and a searcher while there was no hierarchy rather a network where each voice counts.

In Group 2, two persons had clear assumptions and that hindered them to find useful information. They were not open-minded and were surprised when they were wrong with their answers. They even argued later in the interviews, they thought the game was incorrect, as an explanation attempt while their wrong assumption must be correct. Two persons were not connected to person three, which tried to argue with logic but could not reach them. When people have strong assumptions that they are right and they do not check their assumptions, that has an effect on the search terms they choose in order to find information.

Group 3 had a hierarchy in which one person took quickly over in this moment when the Group left the research lab and started to measure the time. S/he was a self-made tour navigator and fed the other two people with information, e.g., what kinds of keywords to use to verify the information. The other two accepted her role taking and used voice commands to make the Group faster.

Group 4 did not act like a group and did not communicate. They had individual processes and did not focus on what each other did or thought. Group collaboration was a burden for them and they did not want to hear the opinion or evidence of others. They only won because they did work individually — which is not a surprise for this kind of game because it was not complex enough to make it a Group effort.

Fig. 2. Form of Cooperation — Networking, each voice counts (Group 1); We don’t want to hear the logic of the other person, our assumption must be right (Group 2); The leader guides our voice commands (Group 3); We don’t debate in group, we try to avoid group discussion (Group 4).
Table 1 presents the relationship of group cooperation format to group actions of identifying authentic online information.

Putting the data together, we tried to understand what we actually have observed and how the different variables are related to each other. We focused on three main variables in this study, a) the groups identify authentic online information (dependent variable), b) equal access to online sources, and c) group dynamics (independent or moderator variables). We assumed that equal access to online information will reduce the impact of group dynamics and all groups apply reasonable, based on facts, strategies to identify authentic online information (see Model 1 in Fig. 3). However, the data actually reveals that group dynamics have had a major impact on groups identifying authentic information and equal access to online sources has been diminished, or at least it did not play a central role, and groups dynamics were the central factor for the group performance to actually find authentic information and correct answers (see Model 2 in Fig. 3). Instead of a reasonable ‘based-on-facts-discussion’ (assumed in Model 1), we experienced group dynamics, in which groups discussed based on beliefs with emotions, and facts did play a second role only (Model 2). The group dynamics were the driver for finding the correct answers in the AR-based activity.

5.1. Implications

Previous studies of how groups discuss information have pointed to an information advantage of one group member that led to an unequal cooperation level based on “hidden profiles” (Stasser and Titus, 1985). It means, when one member has access to information but the others do not, group discussions tend to proceed on an unequal level of cooperation and decision-making because it is influenced by the person with more information while the others have difficulties getting their voices.

Table 1. Patterns of group cooperation in relation to groups actions to identify authentic information.

| Group  | Form of cooperation | Group action of identifying authentic online information (8 tasks) |
|--------|---------------------|---------------------------------------------------------------|
| Group 1| Networking, each voice counts. Network of equal members. | Finished the activity in 51 minutes, score of 3700, had 5 tasks correctly, ranked 3rd => no effective group |
| Group 2| “We don’t want to hear the logic of the other person; our assumption must be right.” Omission of one group member | Longest time to finish, score of 2800, had 4 tasks correctly, ranked 4th => no effective group |
| Group 3| The leader guides the ‘voice search commands’. One person guides the others. | Fastest group in 25 minutes, score of 3900, had 6 tasks correctly, ranked 2nd => very effective group |
| Group 4| “We don’t debate in group”, group tried to avoid group discussion. No collaborative reasoning. | Finished the activity in 45 minutes, highest points of 4300, had 7 tasks correctly, ranked 1st => Most effective ‘group’ |
heard (Xiao et al., 2016; Stasser et al., 1995). Information exchange with un-equal access to information, therefore, is not a cooperative task but a motivated process, “whereby members deliberately select what information to mention and how to mention it to particular members in order to satisfy goals” (Wittenbaum et al., 2007). In this study, we reduced the hidden profiles by giving each member same access to all information. When following Wittenbaum and others theories, one would assume, that groups with reduced hidden profiles would perform better than groups with hidden profiles. However, this study showed, this is not the case. Equal access to information for all group members, that lead to a reduction of hidden profiles, is not the main factor for group performance but in-group dynamics still plays a central factor.

In this study, we used mobile devices with Internet access to ensure that every group member had the same information at hand supporting the ‘democratization’ of information, simply put, equal access to all information for all. With this in mind, we expected that such democratization of information would support equality of group members as it was the case with Group 1; they were equal cooperation partners. However, as the other three Groups showed, the level of cooperation decreased. In Group 2, two people excluded the third person although Person 3 applied logical thinking and gave useful arguments for the right answer. One could argue with Stasser et al. (1986), “information that is held by only one member is omitted from discussion” but in our study, information was actually equally available to all members. Although all had equal access, two members did not question their own assumptions and were trapped by confirmation bias strategies and did not try to search for authentic information (Nickerson, 1998). In Group 3, there was one person who guided the others as followers and searchers for information. Group 4 had no collaboration.

We build a new theory here that the mobile device — which gives equal access to information— does not necessarily lead to effective reasonable fact-based discussions in small groups. Group interactions and informal roles are stronger than
information equality, meaning that group dynamics outweigh information access, and thus impact discussion and decision-making more than the fact itself, even in such situations where all participants had equal information at hand. Simply put, it is not the information that makes a group work or perform better than others, even if all have same information available, the group dynamics and interactions are the major factors that decides about the group performance.

For education, it means, when teachers want to support cooperation among students, access to information is not enough, rather instructional guidelines are needed, e.g., supporting Group contracts clarifying input by each member. Also, not all group tasks need equal cooperation levels to be successful, however, for those where equality matters, access to information is necessary but not sufficient to support group performance.

5.2. Limitations

This exploration study was designed to explore small group collaboration, in particular, how adults in small groups discuss and identify false and correct information by using online sources. We used the context of rather neutral information and not politics or research topics, in which participants argued, they would have been more serious in searching for reliable, trustworthy information versus daily conversational topics. Moreover, the small size limits the generalization of the findings, however, lays foundation for larger or experimental studies.

6. Conclusion

Previous research has focused on individuals and their ability to identify false web-based information. Our study focused on small groups in a mobile setting outdoors simulating daily group conversations. The study explored that equal access to information and facts is not the main factor contributing to group performance but in-group dynamics are essential; different patterns of in-group dynamics impact group performance differently. Equal access to online sources does not have the same impact on identifying authentic information as group dynamics have; group dynamics have a stronger impact on group discussions and group performance than equal access to information.

As digital spaces continue to be redesigned and influenced by technology, this study has presented findings that have implications for teaching and 21st century learners. Equal access to digital or AR augmented information using mobile technology in an outdoor setting does not guarantee reasonable ‘based-on-facts-discussion’. Group dynamics play an essential role in identifying real and fake information even when given same facts to all. If educators understand these group behaviors then they can better support students in evaluating online information and educate
students about the negative impacts of group discussions on identifying authentic online information.

For AR related research, this study has implications too. How will people know in the near future, when everything around us is AR or VR presented visualized and augmented information, that such augmented information is based on true facts, and how can we, as researchers, make sure that people can actually identify AR information as authentic information that is not misleading?

Declarations

Author contribution statement

Isa Jahnke: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Michele Meinke Kroll: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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The authors declare no conflict of interest.

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