Thaleia Deniozou
Department of Arts and Humanities
Brunel University London
London, UK
thaleia.deniozou@brunel.ac.uk

Mariza Dima
Department of Arts and Humanities
Brunel University London
London, UK
mariza.dima@brunel.ac.uk

Chris Cox
Department of Arts and Humanities
Brunel University London
London, UK
chris.cox@brunel.ac.uk

ABSTRACT

Taking effective notes is an important skill in academic and professional settings and one that is cultivated primarily in Higher Education (HE). However, students often find it difficult to effectively record important information in their notes [37], while it has been suggested that they often record less than 50% of the key information of a lecture [15].

Games can be a powerful way to help students learn [30]. Yet, to

facilitate and support this process in various contexts are explored in literature, with studies looking at natural note-taking [14], note-taking in the digital age, exploring areas such as mobile technology implications [55], the use of wireless technologies for collaborative note-taking [58], and the use of the iPad for innovative note-taking [4]. However, there is only but scarce empirical evidence in literature on the use of game-based learning to assist the development of note-taking skills. The study presented in this article explores practically the use of educational games for note-taking focussing on the game design approach.

2 Game-based Learning for Skills Development

Game-

objectives, thus allowing skills to be developed incidentally as learners find

responsibility for every area of production throughout the entire development cycle.

The participation process mimics that of the industry. Each year students apply with a cover letter explaining whether they would like to undertake the role of producer, designer, programmer or artist. The producer is responsible for managing the team and making sure everything is on track and liaising with any external parties. In this instance, the producer was the main liaison between the student team, the researchers and key stakeholders such as members of the University's Academic Skills Service (ASK) team and members of the Disability and Dyslexia Service (DDS) team. *Investigate: Tudors* was developed in three months in a studio-based environment. The team of researchers supervising the development, visited the students daily to ensure the smooth development of the game, and to provide guidance and technical support. Students were also involved in design workshops aimed at developing the learning and design objectives of the game and experienced seeing first-hand the planning and development of a game-

Figure 6: Crime scene investigation.

The “Strand Strangler” level is about bringing down a terrifying serial killer in a time without fingerprints and DNA evidence. The aim is to investigate five murders conducted in a short period of time and interrogate witnesses in order to collect useful notes to help identify the killer. Gameplay features crime scene inspections to gather further evidence from the victims (Fig.6). In this level skills like surmisal of information, information gathering and conflicting information as well as validity inspection can be practiced.

“Drake’s Armada” is a naval officers level which utilises a strategy approach to gameplay. The player is tasked with developing the right strategy for battle against a foreign invasion to protect the country and the Queen. To successfully lead ships to battle, the player must learn about different battle tactics and ship formations. Information on possible generals, to best face opponents and lead to victory with minimal casualties, should also be gathered. Once all relevant information has been gathered in the form of player notes, players are asked to complete a battle report as seen in Fig.7. This level helps practice abbreviation, information gathering and attribution.

Figure 7: Battle planning report.

The “Potion Commotion” level features puzzle elements via alchemy and helps players practice heavy information gathering and surmisal of information over extended time. Here the player is first tutored in the art of potion making via noting down recipes as to how to mix different ingredients to create different types of potions (Fig.8).

Figure 8: Potion making interface. Notes appear on the bottom right and recipe progress on the top left.

The most effective way to take notes to facilitate heavy information gathering in this level, is to avoid noting everything down, since overly wordy notes are unnecessary for potion recipes and will make it difficult for the player to go back and review specific content when needed. This mechanic draws on Friedman [28] who discusses how organised, coded and shorter notes reduce the burden on the note-taker’s working memory and put the focus on comprehension.

Figure 9: Matchmaking interface.

Puzzle elements and decision making are utilised in the later part of this level, where the player is tasked by the Queen to find suitable matches between lords and ladies of the court, to strengthen bonds between countorhe most eTQq0.00000912 0 612 792 reW*nB

matchmaking report (Fig.9), based on information gathered regarding individual wants and personalities.

Cues are provided throughout the game to emphasise the importance of the information provided [37]. As dialogue progresses during a scenario, such cues can be presented via repetition, use of pauses, or punctuation marks and there is also the use of a quill icon that only appears on the screen when the player should be taking notes, as a visual indication of important information being communicated (Fig. 10). The game features an awards system where players are rewarded based on their performance. This system provides a further incentive to do well and progress. King, Delfabbro & Griffiths [38] found rewards and rare game items amongst the most enjoyable aspects of gameplay. Rewards are stored in an inventory in the form of trophies and can include prizes like a horse or a ship (Fig.11). As players progress, better rewards are unlocked.

Figure 10: Quill icon indication during tutorial (top right).

Figure 11: Awards inventory featuring rewards.

Mimicking distractions in real life lecture settings was another aim of the game design. To mimic distractions, animations were incorporated into some game screens in an attempt to distract the player when taking notes. An example can be seen in Fig.12, where a dog walks by the alley in the background while the suspect is talking. These allow players to practise not getting distracted, a skill which can then be carried forward into real lecture settings.

Figure 12: Distractions to mimic real life lecture settings.

Informed by microlearning design [16], *Investigate: Tudors* includes hints and tips on the loading screens, a time during which players are briefly idle. Microlearning is based on the idea of developing small chunks of learning content and presenting them in a series of microlearning units [34]. The hints and tips provided were informed by consultations with ASK advisors, as well as literature on effective note-taking practices. The hint shown on Fig.13
information you have already written down or know, focus on

which in the context of note-taking should be balanced between comprehension of information and production of notes, via identification of important and non-repeating (rt)4( )-3621c01 0-4(o[((g)13( )-10

used in the survey (Appendix A.1) were informed by Whitton's questionnaire to measure post- experiential engagement with educational games [61] and crafted with respect to the identified learning heuristics. For example, questions 1,3,5,10 and 11 of the survey (A.1) addressed L1, question 4 and 9 addressed L2, and questions 2,6,7 and 8 addressed L3. The focus groups questions (Appendix A.2) were more open-

[29] Robert M. Gagne, Leslie J. Briggs, and Walter W. Wager. 1974. *Principles of instructional design*. Rinehart and Winston.
[30] James Paul. Gee. 2007. *What video games have to teach us about learning and literacy*. Palgrave Macmillan, London.
[31] Peter Hodson, Michael Connolly, and Danny Saunders. 2001. Can Computer-based Learning Support Adult Learners? *Journal of Further and Higher Education* 25, 3: 325–335. DOI: http://doi.org/10.1080/03098770120077685
[32] Peter C. Honebein. 1996. Seven goals for the design of constructivist learning environments. *Constructivist learning environments: Case Studies in Instructional Design*, 11-24.
[33] Wenhao David Huang, Tristan E. Johnson, and Seung-Hyun Caleb Han. 2013. Impact of online instructional game features on college students' perceived motivational support and cognitive investment: A structural equation modeling study. *The Internet and Higher Education* 17: 58–68. DOI : http://doi.org/10.1016/j.iheduc.2012.11.004
[34] Theo Hug, Manfred Lindner and Peter A. Bruck. 2006. Microlearning: Emerging Concepts, Practices and Technologies after e-Learning. *Proceedings of Microlearning: Learning & Working in New Media*. Innsbruck University Press.
[35] Richard Jacques, Jenny Preece, and Tom Carey. 1995. Engagement as a Design Concept for Multimedia. *Canadian Journal of Learning and Technology / La revue canadienne de l'apprentissage et de la technologie* 24, 1. 49-59. DOI : http://doi.org/10.21432/t2vg77
[36] Kenneth A. Kiewra. 1989. A review of note-taking: The encoding-storage paradigm and beyond. *Educational Psychology Review* 1, 2: 147–172. DOI: http://doi.org/10.1007/bf01326640
[37] Kenneth A. Kiewra, Tiphaine Colliot and Junrong Lu. 2018. Note this: How to improve student note taking. IDEA Paper #73. The IDEA Center. http://www.ideaedu.org, Accessed 23 February 2020.
[38] Daniel L. King, Paul H. Delfabbro, and Mark D. Griffiths. 2010. The Role of Structural Characteristics in Problematic Video Game Play: An Empirical Study. *International Journal of Mental Health and Addiction* 9, 3: 320–333. DOI: http://doi.org/10.1007/s11469-010-9289-y
[39] Malcolm S. Knowles. 1998. *The adult learner: the definitive classic in adult education and human resource development: 5th ed*. Butterworth-Heinemann, Woburn, MA.
[40] Keiichi Kobayashi. 2006. Combined Effects of Note-Taking/-Reviewing on Learning and the Enhancement through Interventions: A meta-analytic review. *Educational Psychology* 26, 3: 459–477. DOI: http://doi.org/10.1080/01443410500342070
[41] Raph Koster. 2004. *A Theory of Fun for Game Design.* Scottsdale, AZ: Paraglyph Press, Inc.
[42] Petros Lameras, Sylvester Arnab, Ian Dunwell, Craig Stewart, Samantha Clarke, and Panagiotis Petridis. 2016. Essential features of serious games design in higher education: Linking learning attributes to game mechanics. *British Journal of Educational Technology* 48, 4: 972–994. DOI: http://doi.org/10.1111/bjet.12467
[43] Mark Lepper and Thomas W. Malone. 1987. Intrinsic motivation and instructional effectiveness in computer-based education. In R. Snow and M. Farr (Eds), *Aptitude, Learning and Instruction, vol. 3: Cognitive and Affective Process Analysis*. Hillside, NJ: Lawrence Erlbaum Associates.
[44] Ming-Chaun Li and Chin-Chung Tsai. 2013. Game-Based Learning in Science Education: A Review of Relevant Research. *Journal of Science Education and Technology* 22, 6: 877–898. DOI: http://doi.org/10.1007/s10956-013-9436-x
[45] Karen Markey and Chris Leeder. 2011. Students' Behaviour Playing an Online Information Literacy Game. *Journal of Information Literacy* 5, 2, 46-65. DOI: http://doi.org/10.11645/5.2.1637
[46] Marmalade Game Studio Ltd. 2018. *Clue/Cluedo: The Classic Mystery Game.* Game [PC]. (17 May 2018). Marmalade Game Studio Ltd., London, UK.
[47] Pam A. Mueller and Daniel M. Oppenheimer. 2018. Corrigendum: The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking. *Psychological Science 25*, 6, 1159-1168. DOI: http://doi.org/10.1177/0956797614524581
[48] Jakob Nielsen. 2009. *Usability engineering*. Morgan Kaufmann, Amsterdam.
[49] David Pinelle and Nelson Wong. 2008. Heuristic evaluation for games. In

PETJ JETQ 0.00000912 0 612 792 reW*nBT/F4 6.96 Tf1 0 0 1 72.7482hn013ra22
Journal of Science Education and EMCln BT /(u)-13(c)-7(t: ET Q Q q 0.0 W* n Bh7(t)-29)-12( )] TJ 25.uch1(2)-3(pW* p(a)9(r28(n)
Technology 22, 6: 877–898. DOI: http://doi.org/10.1007/s10956-013-9436-x 9T o0edHunBDC q 0.008(14<004800480047>3<00480055>-8<0011>-3<0003>-59<0015>-17<00130014>1
9 q .024 287.69 Tm 0 g 0 G [(T)-7(A)5(.)] TJ ET Q 3339 79250311 TJ T(3.9020)3(s)7e 20 612 Rad 5 70

A.2. Playtest Questions